World Water Assessment Programme

WORLD WATER ASSESSMENT PROGRAMME

LA PLATA BASIN CASE STUDY

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WORLD WATER ASSESSMENT PROGRAMME

LA PLATA BASIN CASE STUDY

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a. International institutions

AECI	Agencia Española de Cooperación Internacional	Spanish International Cooperation Agency
BID / IDB	Banco Interamericano de Desarrollo	Inter-American Development Bank
BM / WB	Banco Mundial	World Bank
CARP	Comisión Administradora del Río de la Plata	Administrative Commission for the La Plata River
CARE	Cooperativa para la Asistencia y la Ayuda en Todas Partes	Cooperative for Assistance and Relief Everywhere, Inc.
CARU	Comisión Administradora del Río Uruguay	Administrative Commission for the Uruguay River
CELADE	Centro Latinoamericano y Caribeño de Demografía	Latin-American and Caribbean Demographic Centre
CEPAL / ECLAC	Comisión Económica para América Latina y el Caribe	Economical Commission for Latin America and the Caribbean
CIC	Comité Intergubernamental Coordinador de los Países de la Cuenca del Plata	Inter-governmental Coordinating Committee of the La Plata Basin Countries
CIH	Comité Intergubernamental de la Hidrovía Paraguay-Paraná	Intergovernmental Committee for the Paraguay-Paraná Waterway
COBINABE	Comisión Binacional para el Desarrollo de la Alta Cuenca de los ríos Bermejo y Grande de Tarija	Binational Commission for the Development of the Upper Basin of the Bermejo and Grande de Tarija Rivers
COMIP	Comisión Mixta Argentino-Paraguaya del Río Paraná	Argentinean-Paraguayan Joint Commission of the Paraná River
CRC	Comisión Mixta Uruguayo-Brasileña para el Desarrollo de la Cuenca del río Cuareim	Joint Uruguayan-Brazilian Commission for the Development of the Cuareim River Basin
CTMFM	Comisión Técnica Mixta del Frente Marítimo	Joint Technical Commission for the Maritime Front
CTMSG	Comisión Técnica Mixta de Salto Grande	Joint Technical Commission of Salto Grande
EBY	Entidad Binacional Yacyretá	Yacyretá Binational Entity
EPA	Agencia de Protección Ambiental	Environmental Protection Agency
FAO	Organización de las Naciones Unidas para la Agricultura y la Alimentación	Food and Agriculture Organization of the United Nations
FMMA / GEF	Fondo Mundial para el Medio Ambiente	Global Environmental Facility
FREPLATA	Proyecto Protección Ambiental del Río de la Plata y su Frente Marítimo: Prevención y Control de la Contaminación y Restauración de Hábitats	Project on Environmental Protection of the La Plata River and its Maritime Front: Pollution Prevention and Control and Habitat Restoration

FONPLATA	Fondo Financiero para el Desarrollo de la Cuenca del Plata	Financial Fund for the Development of the La Plata Basin
IBRD	Banco Internacional de Reconstrucción y Desarrollo	Internacional Bank for Reconstruction and Development
JEXIM	Banco de Exportación-Importación de Japón	Export-Import Bank of Japan
MERCOSUR / MERCOSUL	Mercado Común del Sur	Southern Cone Common Market
OEA / OAS	Organización de los Estados Americanos	Organization of American States
OMS / WHO	Organización Mundial de la Salud	World Health Organization
OPS / PAHO	Organización Panamericana de la Salud	Pan-American Health Organization
PNUD / UNDP	Programa de las Naciones Unidas para el Desarrollo	United Nations Development Programme
PNUMA / UNEP	Programa de las Naciones Unidas para el Medio Ambiente	United Nations Environmental Programme
PROCON	Programa de Calidad de Aguas y Control de la Contaminación del Río Uruguay	Uruguay River Water Quality and Pollution Control Programme
PyMes / SMEs	Pequeñas y Medianas Empreesas	Small and Medium-Sized Enterprises
UICN / IUNC	Unión Mundial para la Conservación de la Naturaleza	The World Conservation Union
ZCPAU	Zona Común de Pesca Argentino-Uruguaya	Argentinean-Uruguayan Common Fishing Zone

b. National institutions (by country)

b.1. Argentina

APN	Administración de Parques Nacionales	National Parks Administration
CFEE	Consejo Federal de la Energía Eléctrica	Electric Energy Federal Council
CENAE	Centro Nacional de Emergencia	National Emergency Centre
COFAPyS	Consejo Federal de Agua Potable y Saneamiento	Federal Council of Drinking Water and Sanitation
COFEMA	Consejo Federal del Medio Ambiente	Federal Council of Environment
COFESA	Consejo Federal de Saneamiento	Federal Council of Sanitation
COHIFE	Consejo Hídrico Federal	Federal Water Council

CONAE	Comisión Nacional de Actividades Espaciales	National Commission of Spatial Activities
CONICET	Consejo Nacional de Investigaciones Científicas y Técnicas	National Council of Scientific and Technical Research
COREBE	Comisión Regional del Bermejo	Regional Commission of the Bermejo River
DNPC	Dirección Nacional de Protección Civil	National Directorate of Civil Protection
DOA	Dirección de Ordenamiento Ambiental	Directorate of Environmental Planning
DPGC	Dirección de Prevención y Gestión de la Contaminación	Directorate of Pollution Prevention and Management
ENOHSA	Ente Nacional de Obras Hídricas de Saneamiento	National Agency of Water Works for Sanitation
ETOSS	Ente Tripartito de Obras y Servicios Sanitarios	Tripartite Agency of Sanitary Works and Services
FFTEF	Fondo Fiduciario del Transporte Eléctrico Federal	Federal Electric Transport Fund
GTRA	Grupo de Trabajo en Recursos Acuáticos	Aquatic Resources Working Group
INA	Instituto Nacional del Agua	National Water Institute
INDEC	Instituto Nacional de Estadística y Censos	National Institute for Statistics and Census
INTA	Instituto Nacional de Tecnología Agropecuaria	National Institute of Agricultural Technology
MECON	Ministerio de Economía y Producción	Ministry of Finance and Production
MECyT	Ministerio de Educación, Ciencia y Tecnología	Ministry of Education, Science and Technology
MINPLAN	Ministerio de Planificación Federal, Inversión Pública y Servicios	Ministry of Federal Planning, Public Investment and Services
MRECIC	Ministerio de Relaciones Exteriores, Comercio Internacional y Culto	Ministry of Foreign Affairs, International Trade and Cult
MSAL	Ministerio de Salud	Ministry of Health
OSN	Obras Sanitarias de la Nación	Sanitary Works of the Nation
PAEPRA	Programa de Abastecimiento Eléctrico a la Población Rural Argentina	Programme for Electricity Supply to the Argentinean Rural Population
PAH	Programa de Pequeños Aprovechamientos Hidroeléctricos	Small Hydroelectric Operations Programme
PAyEEE	Programa de Ahorro y Eficiencia Energética en Edificios Públicos	Programme for Energy Saving and Efficiency in Public Buildings
PFCI	Plan Federal de Control de Inundaciones	Federal Flood Control Plan
PNDT	Política de Estado de Desarrollo Territorial de la Argentina	National Policy of Territorial Development of Argentina

PPI	Programa de Protección contra Inundaciones	Flood Protection Programme
PROCAL	Programa Calidad de los Alimentos Argentinos	Argentine Food Quality Programme
ProderNEA	Proyecto de Desarrollo Rural de las Provincias del Noreste Argentino	Project on Rural Development of Northeast Argentinean Provinces
PROINDER	Programa Social Agropecuario	Social Agricultural Programme
PROSAP	Programa de Servicios Agrícolas Provinciales	Programme of Provincial Agriculture Services
SAGyPA	Secretaría de Agricultura, Ganadería, Pesca y Alimentos de la Nación	National Secretary of Agriculture, Livestock, Fishing and Food
SAyDS	Secretaría de Ambiente y Desarrollo Sustentable	Secretariat of Environment and Sustainable Development
SHN	Servicio de Hidrografía Naval	National Hydrography Service
SIFEM	Sistema Federal de Emergencias	Federal Emergencies System
SMN	Servicio Meteorológico Nacional	National Weather Service
SOP	Secretaría de Obras Públicas de la Nación	National Secretariat of Public Works
SNAP	Servicio Nacional de Agua Potable	National Service of Drinking Water
SSRH	Subsecretaría de Recursos Hídricos de la Nación	National Undersecretariat of Water Resources
UPLCS	Unidad de Producción Limpia y Consumo Sustentable	Clean Production and Sustainable Consumption Unit

b.2. Bolivia

ANESAPA	Asociación Nacional de Empresas de Servicio de Agua Potable	National Association of Drinking Water Service Companies
CGIAB	Comité Nacional para la Gestión Integrada del Agua en Bolivia	National Committee for Integrated Water Management in Bolivia
CNI	Cámara Nacional de Industrias	National Chamber of Industries
CNTL	Centro Nacional de Tecnologías Limpias	National Clean Technologies Centre
CONARAD	Consejo Nacional para la Reducción de Riesgos y Atención de Desastres y/o Emergencias	National Council for Risk Reduction and Disasters and/or Emergency Care
CODIAGs	Consejos Departamentales Interinstitucionales del Agua	Interinstitutional Departmental Water Councils
CONIAG	Consejo Interjurisdiccional del Agua	Interjurisdiccional Council of Water

CPTS	Centro de Promoción de Tecnologías Sostenibles	Sustainable Technologies Promotion Centre
DGCTC	Dirección General de Clasificación de Tierras y Cuencas	General Directorate of Basin and Land Classification
EBRP	Estrategia Boliviana de Reducción de la Pobreza	Bolivian Strategy for Poverty Reduction
ECSs	Entidades de Carácter Social	Social Status Entities
ENDAR	Estrategia Nacional de Desarrollo Agropecuario y Rural	National Strategy of Agriculture, Livestock and Rural Development
EPSAs	Entidades Prestadoras de Servicios de Agua Potable y Alcantarillado Sanitario	Drinking Water and Sanitation Services Providing Entities
FUNDA-PRO	Fundación para la Producción	Fund for Production
INE	Instituto Nacional de Estadística	National Institute for Statistics
INRA	Instituto Nacional de Reforma Agraria	National Institute for Agrarian Reform
MACA	Ministerio de Asuntos Campesinos y Agropecuarios	Ministry of Peasant and Agricultural Affairs
MAGDR	Ministerio de Agricultura, Ganadería y Desarrollo Rural	Ministry of Agriculture, Livestock and Rural Development
MDSP	Ministerio de Desarrollo Sostenible y Planificación	Ministry of Sustainable Development and Planning
MDE	Ministerio de Desarrollo Económico	Ministry of Economic Development
MSD	Ministerio de Salud y Deportes	Ministry of Health and Sports
MVSB	Ministerio de Vivienda y Servicios Básicos	Ministry of Housing and Basic Services
OTB	Organizaciones Territoriales de Base	Base Territorial Organisations
OTNPB	Oficina Técnica Nacional de los ríos Bermejo y Pilcomayo	National Technical Office for the Pilcomayo and Bermejo Rivers
PASA	Programa de Apoyo a la Seguridad Alimentaria	Food Security Support Programme
PLUS	Planes de Uso del Suelo	Land Use Plans
PMOT	Planes Municipales de Ordenamiento Territorial	Municipal Plans on Territorial Planning
PNC	Política Nacional de Compensación	National Policy of Compensation
PROANDES	Programa Subregional Andino de Servicios Básicos contra la Pobreza	Andean Subregional Programme for Basic Services against Poverty
PRONAR	Programa Nacional de Riego	National Programme of Irrigation

PRONER	Programa de Electrificación Rural	Rural Electrification Programme
PRONIA	Programa Nacional de Nutrición e Inocuidad Sanitaria	National Programme for Nutrition and Food Innocuousness
SEDERI	Servicio Departamental de Riego	Departmental Irrigation Service
SENARI	Servicio Nacional de Riego	National Irrigation Service
SIRENARE	Sistema de Regulación de Recursos Naturales Renovables	Regulation System for Renewable Natural Resources
SIRESE	Sistema de Regulación Sectorial	Sectorial Regulation System
SISPLAN	Sistema Nacional de Planificación	National Planning System
SISRADE	Sistema Nacional para la Reducción de Riesgos y Atención de Desastres y/o Emergencias	National System for Risk Reduction and Disasters and/or Emergency Care
SNDC	Servicio Nacional de Defensa Civil	National Civil Defence Service
SMNH	Servicio Nacional de Meteorología e Hidrología	National Weather and Hydrology Service
VME	Viceministerio de Electricidad y Energías Alternativas	Viceministry of Electricity and Alternative Energies

b.3. Brazil

ABAS	Associação Brasileira de Aguas Subterrâneas	Brazilian Association of Groundwater
ABES	Associação Brasileira de Engenharia Sanitária e Ambiental	Brazilian Association of Sanitary Engineering
ABID	Associação Brasileira de Irrigação e Drenagem	Brazilian Associaton of Irrigation and Drainage
ABRH	Associação Brasileira de Recursos Hídricos	Brazilian Association of Water Resources
ANA	Agência Nacional de Águas	National Water Agency
ANEEL	Agência Nacional de Energía Eléctrica	National Agency of Electric Power
ANP	Agência Nacional do Petróleo	National Oil Agency
CAESB	Companhia de Saneamento de Brasilia	Sanitation Company of Brasilia
CASAN	Companhia Catarinense de Águas e Saneamento	Water and Sanitation Company of Santa Catarina
CBEE	Comercializadora Brasileira de Energia Emergencial	Brazilian Emergency Power Company

CCC	Conta de Consumo de Combustiveis	Fuel Consumption Account
CDE	Conta de Desenvolvimento Energético	Energy Development Account
CEEIBH	Comitê Especial de Estudos Integrados de Bacias Hidrográficas	Special Committee for Integrated Studies on River Basins.
CENAD	Centro Nacional de Gerenciamiento de Riscos e Desastres	National Risk and Disaster Management Centre
CETESB	Compahia Estadual de Tecnologia de Saneamento Ambiental do São Paulo	São Paulo State Environmental Sanitation Technology Company
CGTEE	Companhia de Geração Térmica de Energia Elétrica	Company of Thermal Electric Power Generation
CHESF	Companhia Hidro Elétrica do São Francisco	São Francisco Hydroelectric Company
CIDEMA	Consórcio Intermunicipal para o Desenvolvimento Integrado das Bacias dos Rio Miranda e Apa	Intermunicipal Committee for the Integrated Development of Miranda and Apa River Basins
CNRH	Conselho Nacional do Recursos Hídricos	National Council of Water Resources
CNTL	Centro Nacional de Tecnologias Limpas	National Clean Technologies Centre
COGERH	Companhia de Gestão dos Recursos Hídricos de Ceará	Ceará's Water Resources Management Company
COMDEC	Coordenadora Municipal de Defesa Civil	Civil Defence Municipal Coordinating Committee
CONAMA	Conselho Nacional do Meio Ambiente	National Environmental Council
COPASA	Companhia de Saneamento de Minas Gerais	Sanitation Company of Minas Gerais
CORSAN	Companhia Riograndense de Saneamento	Sanitation Company of Rio Grande do Sul
CPRM	Serviço Geológico do Brasil	Brazil Geological Service
CTCT	Câmara Técnica de Ciência e Tecnología	Technical Chamber of Science and Technology
DAEE	Departamento de Aguas e Energia Eléctrica do Estado do São Paulo	São Paulo State's Department of Water and Power
DNPM	Departamento Nacional de Produção Mineral	National Department of Mineral Production
DRD	Departamento de Resposta aos Desastres e Reconstrução	Department of Response to Disasters and Reconstruction
ELETROBRAS	Centrais Elétricas Brasileiras S.A.	Brazilian Power Stations
ELETRONUCLEAR	Electrobrás Termonuclear S.A.	Thermo-nuclear Eletrobrás
ELETRONORTE	Centrais Elétricas do Norte do Brasil S.A.	Northern Brazilian Power Stations

ELECTROSUL	Eletrosul Centrais Elétricas S.A.	Electrosul Power Stations
EPE	Empresa de Pesquisa Energética	Energy Research Company
FEHIDRO	Fundo Estadual de Recursos Hidricos	Water Resources State Fund
FEMA	Fundação Estadual do Meio Ambiente de Mato Grosso, Diretoria de Recursos Hídricos	Mato Grosso's State Foundation for the Environment, Directorate of Water Resources
FHIDRO	Fundo de Recuperação, Proteção e Desenvolvimento Sustentável das Bacias Hidrográficas do Estado de Minas Gerais	Recovery, Protection and Sustainable Fund for the River Basins of Minas Gerais State
FIEMG	Federação de Indústrias do Estado do Minas Gerais	Minas Gerais State Industries Federation
FIEMT	Federação de Indústrias do Estado do Mato Grosso	Mato Grosso State Industries Federation
FIESC	Federação de Indústrias do Estado de Santa Catarina	Santa Catarina State Industries Federation
FUNASA	Fundação Nacional de Saúde	National Health Foundation
IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis	Brazilian Institute of Environment and Natural Renewable Resources
IBGE	Instituto Brasileiro de Geografia e Estatistica	Brazilian Institute of Geography and Statistics
IGAM	Instituto Mineiro de Gestão das Aguas	Minas Gerais's Institute of Water Management
IRGA	Instituto Rio Grandense do Arroz	Rio Grandense Institute of Rice
MAPA	Ministério de Agricultura, Pecuária e Abastecimento	Ministry of Agriculture, Livestock and Supply
MCT	Ministerio da Ciência e Tecnologia	Ministry of Science and Technology
MIN	Ministério da Integração Nacional	Ministry of National Integration
MMA	Ministério do Meio Ambiente	Ministry of Environment
MME	Ministério de Minas e Energía	Ministry of Mines and Energy
PAS	Programa de Águas Subterraneas	Groundwater Programme
PASS/IDB	Programa de Ação Social em Saneamento	Programme for Social Action in Sanitation
PAT Prosanear	Programa de Urbanização de Favelas e Saneamento Integrado em Areas de Baixa Renda	Programme for the Urbanisation of Favelas and Integrated Sanitation in Low-income Areas
PLANIRD	Plano Nacional de Irrigação e Drenagem	National Plan of Irrigation and Drainage

PNDPA	Programa Nacional de Desenvolvimento da Pesca Armadora	National Amateur Fishing Development Programme
PNRH	Plano Nacional de Recursos Hídricos	National Water Resources Plan
PNS	Plano Nacional de Saúde – Um Pacto pela Saúde no Brasil	Health National Programme – A Pact for Health in Brazil
PROAGUA	Programa Federal de Gestão de Recursos Hídricos	Federal Water Resources Management Programme
PROAGUA-Semi-Arido	Programa de Desenvolvimento de Recursos Hídricos para o Semi-Arido Brasileiro	Brazilian Semi-Arid Water Resources Development Programme
PROFIR	Programa de Financiamento de Equipamentos de Irrigação	Programme for Financing of Irrigation Equipment
PROINE	Programa de Irrigação do Nordeste	Northeast Irrigation Programme
PROINFA	Programa de Incentivo às Fontes Alternativas de Energia Elétrica	Alternative Sources of Electric Energy Incentive Programme
PROMINP	Programa de Movilização da Indústria Nacional de Petróleo e Gás Naural	Oil and Natural Gas National Industry Mobilisation Programme
PRONI	Programa Nacional de Irrigação	National Programme of Irrigation
PROURB	Projeto de Desenvolvimento Urbano e Gestão de Recursos Hídricos do Estado de Ceará	Ceará State's Urban Development and Water Resources Management Project
PROVARZEAS	Programa de Aproveitamento Racional de Várzeas Irrigadas	Programme for Rational Development of Irrigated Basins
SAAEs	Serviço Autônomo de Água e Esgoto	Water and Sewer Autonomous Services
SABESP	Companhia de Saneamento Básico do Estado de São Paulo	Basic Sanitation Company of São Paulo State
SANEAGO	Saneamento de Goiás	Sanitation of Goiás
SANEMAT	Companhia de Saneamento do Estado do Mato Grosso	Sanitation Company of Mato Grosso State
SANEPAR	Companhia de Saneamento do Paraná	Sanitation Company of Paraná
SANESUL	Companhia de Saneamento do Estado do Mato Grosso do Sul	Sanitation Company of Mato Grosso do Sul State
SDS	Secretaría de Estado do Desenvolvimento Social, Urbano e de Meio Ambiente de Santa Catarina	Santa Catarina's State Secretariat of Social, Urban and Environmental Development
SEDEC	Secretaría Nacional de Defesa Civil	National Secretariat of Civil Defence
SEMA- Mato Grosso do Sul	Secretaría Estadual de Meio Ambiente de Mato Grosso do Sul	Mato Grosso do Sul's State Secretariat of Environment
SEMA- Rio Grande do Sul	Secretaría Estadual de Meio Ambiente de Rio Grande do Sul	Rio Grande do Sul's State Secretariat of Environment
SEMARH – Brasilia	Secretaría de Meio Ambiente e Recursos Hídricos (Brasilia)	Brasilia's Secretariat of Environment and Water Resources

SEMARH – Brasilia	Secretaría de Meio Ambiente e Recursos Hídricos do Estado de Goiás	Goiás State's Secretariat of Environment and Water Resources
SENAI	Serviço Nacional de Aprendizagem Industrial	National Industrial Learning Service
SIMARN	Sistema de Monitoreamento Ambiental e de los Recusos Naturais por Satellite	Satellite Environmental and Natural Resources Monitoring System
SIN	Sistema Interligado Nacional	Interconnected National System
SINDEC	Sistema Nacional de Defesa Civil	National Civil Defence System
SISVAN	Sistema de Vigilância Alimentar e Nutricional	Surveillance System of Food and Nutrition
SRH	Secretaría de Recursos Hídricos	Secretariat of Water Resources
SUDERSHA	Superintendencia de Desarrollo de Recursos Hídricos e Saneamento Ambiental do Estado de Paraná	Paraná State's Superintendancy of Water Resources Development and Environmental Sanitation
SUS	Sistema Unico de Saúde	Unified Health System

b.4. Paraguay

ANDE	Administración Nacional de Electricidad	National Electricity Administration
ANNP	Administración Nacional de Puertos	National Administration of Navigation and Ports
APRH	Asociación Paraguaya de Recursos Hídricos	Paraguayan Association of Water Resources
CAPA	Cámara Paraguaya del Agua	Paraguayan Water Chamber
CEN	Comité de Emergencia Nacional	National Emergency Committee
CMMAH	Centro Multiuso de Monitoreo Ambiental	Multi-Use Environmental Monitoring Centre
CONAM	Consejo Nacional Ambiental	National Environmental Council
CORPOSANA	Corporación de Obras Sanitarias	Sanitary Works Corporation
DGEEC	Dirección General de Estadística, Encuestas y Censos	General Directorate of Statistics, Surveys and Census
DGPyCRH	Dirección General de Protección y Conservación de los Recursos Hídricos	General Directorate of Water Resources Protection and Conservation
DINCAP	Dirección Nacional de Coordinación y Administración de Proyectos	National Directorate of Project Coordination and Administration
DINGRAED	Dirección Nacional de Gestión de Riesgos y Atención de Emergencias y Desastres	Natoinal Directorate for Risk Management and Emergeny and Disaster Care

DMH	Dirección Nacional de Meteorología e Hidrología	National Directorate of Meteorology and Hydrology
ENREPD	Estrategia de Reducción de la Pobreza y la Desigualdad	Strategy to Reduce Poverty and Inequality
ERSSAN	Ente Regulador de Servicios Sanitarios del Paraguay	Sanitary Services Regulatory Agency of Paraguay
ESSAP	Empresa de Servicios Sanitarios del Paraguay	Sanitary Service Company of Paraguay
FEV	Fondos de Estudio de Viabilidad	Viability Study Funds
GAR	Gestión Ambiental Rentable	Profitable Environmental Management
GVME	Gabinete del Viceministro de Minas y Energía	Cabinet of the Viceminister of Mines and Energy
MAG	Ministerio de Agricultura y Ganadería	Ministry of Agriculture and Livestock
MIC	Ministerio de Industria y Comercio	Ministry of Industry and Trade
MOPC	Ministerio de Obras Públicas y Comunicaciones	Ministry of Public Works and Communications
MSPBS	Ministerio de Salud Pública y Bienestar Social	Ministry of Public Health and Social Welfare
PETROPAR	Petróleos Paraguayos	Paraguayan Oils
SEAM	Secretaría del Ambiente	Secretariat of Environment
SENASA	Servicio Nacional de Saneamiento Ambiental	National Environmental Sanitation Service
SISNAM	Sistema Nacional Ambiental	National Environmental System
SSME	Subsecretaría de Minas y Energía	Undersecretariat of Mines and Energy
VME	Viceministerio de Minas y Energía	Viceminitry of Mines and Energy

b.5. Uruguay

ANMYPE	Asociación Nacional de Medianas y Pequeñas Empresas	National Association of Small and Medium-Size Companies)
ASIQUR	Asociación de Industrias Químicas del Uruguay	Chemical Industries Association of Uruguay
COTAMA	Comisión Técnica Asesora de la Protección del Medio Ambiente	Technical Advisory Commission for Environmental Protection
DEIA	División Evaluación de Impacto Ambiental	Environmental Impact Assessment Division
DGRNR	Dirección General de Recursos Naturales Renovables	General Directorate of Renewable Natural Resources

DIEA	Dirección de Estadística Agropecuaria	Directorate of Agricultural and Livestock Statistics
DINACyT	Dirección Nacional de Ciencia, Tecnología e Innovación	National Directorate of Science, Technology and Innovation
DINAMA	Dirección Nacional de Medio Ambiente	National Directorate of Environment
DINAMIGE	Dirección Nacional de Minería y Geología	National Directorate of Mining and Geology
DINARA	Dirección Nacional de Recursos Acuáticos	National Directorate of Aquatic Resources
DINOT	Dirección Nacional de Ordenamiento Territorial	National Directorate for Territorial Planning
DNETN	Dirección Nacional de Energía y Tecnología Nuclear	National Directorate of Nuclear Energy and Technology
DNH	Dirección Nacional de Hidrografía	National Directorate of Hydrography
IMM	Intendencia Municipal de Montevideo	Municipal Intendancy of Montevideo
INDA	Instituto Nacional de Alimentación	National Food Institute
INE	Instituto Nacional de Estadística	National Institute of Statistics
INIA	Instituto Nacional de Investigación Agropecuaria	National Agricultural and Livestock Research Institute
LATU	Laboratorio Técnico del Uruguay	Technological Laboratory of Uruguay
MEC	Ministerio de Educación y Cultura,	Ministry of Culture and Education
MGAP	Ministerio de Ganadería, Agricultura y Pesca	Ministry of Livestock, Agriculture and Fishing
MIEM	Ministerio de Industria, Energía y Minería	Ministry of Industry, Energy and Mining
MTOP	Ministerio de Transporte y Obras Públicas	Ministry of Transport and Public Works
MVOTMA	Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente	Ministry of Housing, Territorial Planning and Environment
OPP	Oficina de Planeamiento y Presupuesto	Office of Planning and Budget
OSE	Obras Sanitarias del Estado	State Sanitary Works
PAN	Plan Alimentario Nacional	National Food Plan
PANES	Plan de Atención Nacional a la Emergencia Social	Plan for National Care of Social Emergency
PIAI	Programa de Integración de Asentamientos Irregulares	Programme for the Integration of Irregular Settlements
PRENADER	Programa para el Manejo de Recursos Naturales y Desarrollo del Riego	Natural Resources Management and Irrigation Development Programme

SNE	Sistema Nacional de Emergencias	National System on Emergencies
UDELAR	Universidad de la República	University of the Republic
UNIT	Instituto Uruguayo de Normas Técnicas	Uruguayan Institute of Technical Rules
UTE	Administración Nacional de Usinas y Transmisiones Eléctricas	National Administration of Power Stations and Electric Transmissions

PART A: BACKGROUND

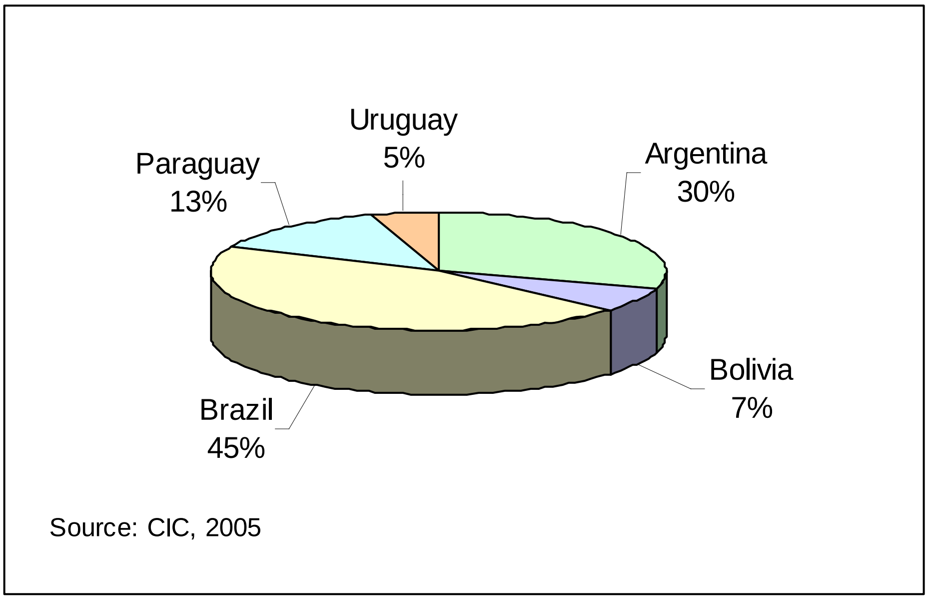
1. General context

1.1. Location of the La Plata Basin

The La Plata River Basin is the fifth largest river basin in the world, extending over 3,100,000 km^2, and its surface area is second only to the Amazon River Basin in South America. It covers an extensive part of central and northern Argentina, southeast Bolivia, almost all the southern part of Brazil, the whole of Paraguay and a large part of Uruguay (see Map 1.1 and Figure 1.1).

Map 1.1. La Plata River Basin

Figure 1.1. La Plata River Basin. Distribution of basin area by country

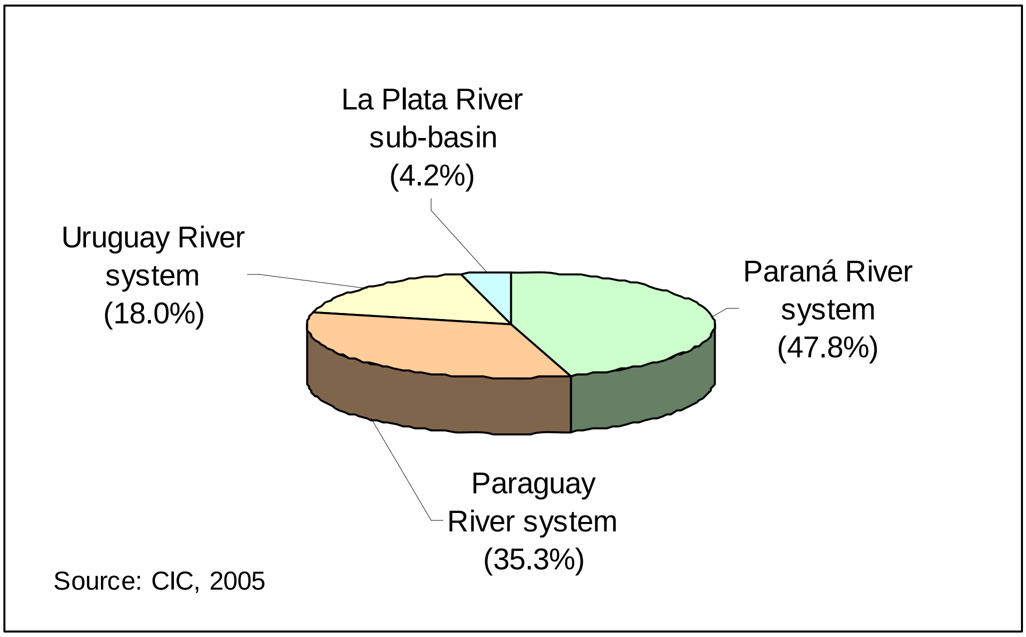


With over 100 million inhabitants, close to fifty major cities (including the five national capitals), seventy five large dams and an economy that represents 70% of the per capita GDP of five countries, the basin has enormous economic and social importance for the region overall.

1.2. General hydrological characteristics of the La Plata Basin

The La Plata Basin has four main sub-basins: the Paraná, Paraguay and Uruguay River systems and the La Plata sub-basin itself; the Paraná River systems is the largest one (see Figure 1.2).

Figure 1.2. La Plata River Basin. Distribution of basin area by sub-basins.



Annual mean rainfall in the La Plata Basin tends to decrease both from north to south and from east to west. Since the major rivers in the basin generally run from north to south, this rainfall regime contributes to the attenuation of the seasonal cycle downstream. The annual mean total rainfall is about 1,100 mm. Meanwhile, the annual average river discharge varies between 23,000 to 28,000 m^3/s (Baetghen *et al.* 2001). Table 1.1 shows other relevant values related to river discharges in the La Plata Basin.

Table 1.1. La Plata River Basin. River discharges (minimum, maximum, historical)

Minimum river discharge	18,300 m^3s^{-1} (September)
Maximum river discharge	23,700 m^3s^{-1} (March)
Historical maximum discharge	72,000 m^3s^{-1} (Winter)
Timing of floods	All year/winter

Source: Baetghen, *et al.* 2001

In terms of discharge, the Paraná River System is the most important in the basin, with a mean annual flow of about 17,000 m^3/s at Corrientes[1]. The Uruguay River system has a mean annual flow of about 4,300 m^3/s, while the Paraguay River System has the lowest capacity with a mean annual flow of approximately 3,800 m^3/s at Puerto Pilcomayo[2].

Long term measurements over a large part of the La Plata Basin show certain trends in climate and rainfall patterns. For example, annual minimum temperatures are increasing by about 1º C per century. Furthermore, hydrological records show evidence of an increase both in rainfall and runoff in the La Plata Basin after 1970. El Niño has also an impact on stream flows in the basin. For example, in the middle section of the Paraná River, the four largest discharges on record followed the four El Niño events of 1905, 1982-1983, 1992 and 1998. In the La Plata Basin as a whole, losses associated with El Niño events were estimated at more than US $ 1 billion.

Severe flooding, with extensive damage to infrastructure and economic production, are frequent occurrences, especially in the Paraná and Uruguay rivers sub-basins. The Paraná River and its tributaries have many riverside towns that are frequently flooded. This is the case in the Argentinean cities of Resistencia, Corrientes, Rosario and Santa Fe.

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[1] Located on the left bank of the Paraná River (Argentina), after its confluence with the Paraguay River
[2] Located on the right bank of the Paraguay River (Argentina), after its confluence with the Pilcomayo River.

2. Major Characteristics

2.1. Topography, Geology and Surface Area

In broad strokes, two main structures can be identified in the La Plata Basin, with a north-to-south orientation. The first one is located on the east: the Mato Grosso massif, somewhat depressed in its northwest portion; the second one is located on the west: the Chaco-Pampean plain, a broad, almost flat region. Between both of them lies the central threshold, which includes the Pantanal. Therefore, the relief is mainly flat, and the highest altitudes are on the edges (see Map 2.1). Along the eastern edge there is an orogenic belt, which is rich in mineral deposits; the Pampean and Subandean Sierras are along the western edge (CIC, 2005).

Map 2.1. La Plata River Basin. Altimetry

Source: Modified from ANNEL, 1999

Five big morpho-structural units are represented in the basin: the Paraná Basin, the Chaco-Pampean Basin, Paraguai Tebicuary, the Eastern Range, and Guaporé (ANEEL, 1999).

The Paraná Basin is a vast stretched-out area, which occupies part of the south of Brazil, the north of Uruguay, the east of Paraguay, and the northeast of Argentina. It is formed by sequences of volcanic rocks and sediments, separated by intraregional unconformity surfaces; the whole is over 7,000 m thick (ANEEL, 1999).

The Chaco Pampean Basin encompasses a broad plain with a north-south direction. Two main processes took place in this plain: a structured sedimentation in a passive margin to the west, and an accumulation in the Bolivian/Brazilian/Paraguayan basement. Both marine and continental sediments are combined in the Bolivian sector. In the rest of the area, tertiary sedimentation forms fluvial and alluvial deposits covering earlier cycles, which were later modified by wind erosion, originating loess plains (ANEEL, 1999).

The Paraguai Tebicuary unit is located along the Paraguay River, on the border between Brazil, Paraguay and Bolivia. It is formed by two craton blocks covered by rocky formations of various ages. One of these two blocks was the setting of the Quaternary evolution that originated the vast Pantanal floodplain (ANEEL, 1999).

The Eastern Range seats on a Proterozoic basement. In Bolivia, this is represented by sedimentation associated with basic effusions and some granite bodies, whereas in Argentina there are slightly metamorphosed sediments with granite intrusion. Over these basements there are formations of various ages that end with lake phases and fluvial deposits, as well as pyroclastic and basaltic effusions, and an important magmatism (ANEEL, 1999).

Lastly, the Guaporé unit is located in the border between Bolivia and Brazil. It makes up the western margin of the Amazonian craton. The unit has a lateritic surface formed in the late Tertiary, with variable altitudes ranging from 400 to 700 meters. Its geology exhibits a great complexity of magmatic and tectonic events, with an age dated as 2,000 million years (ANEEL, 1999).

2.2. Climate

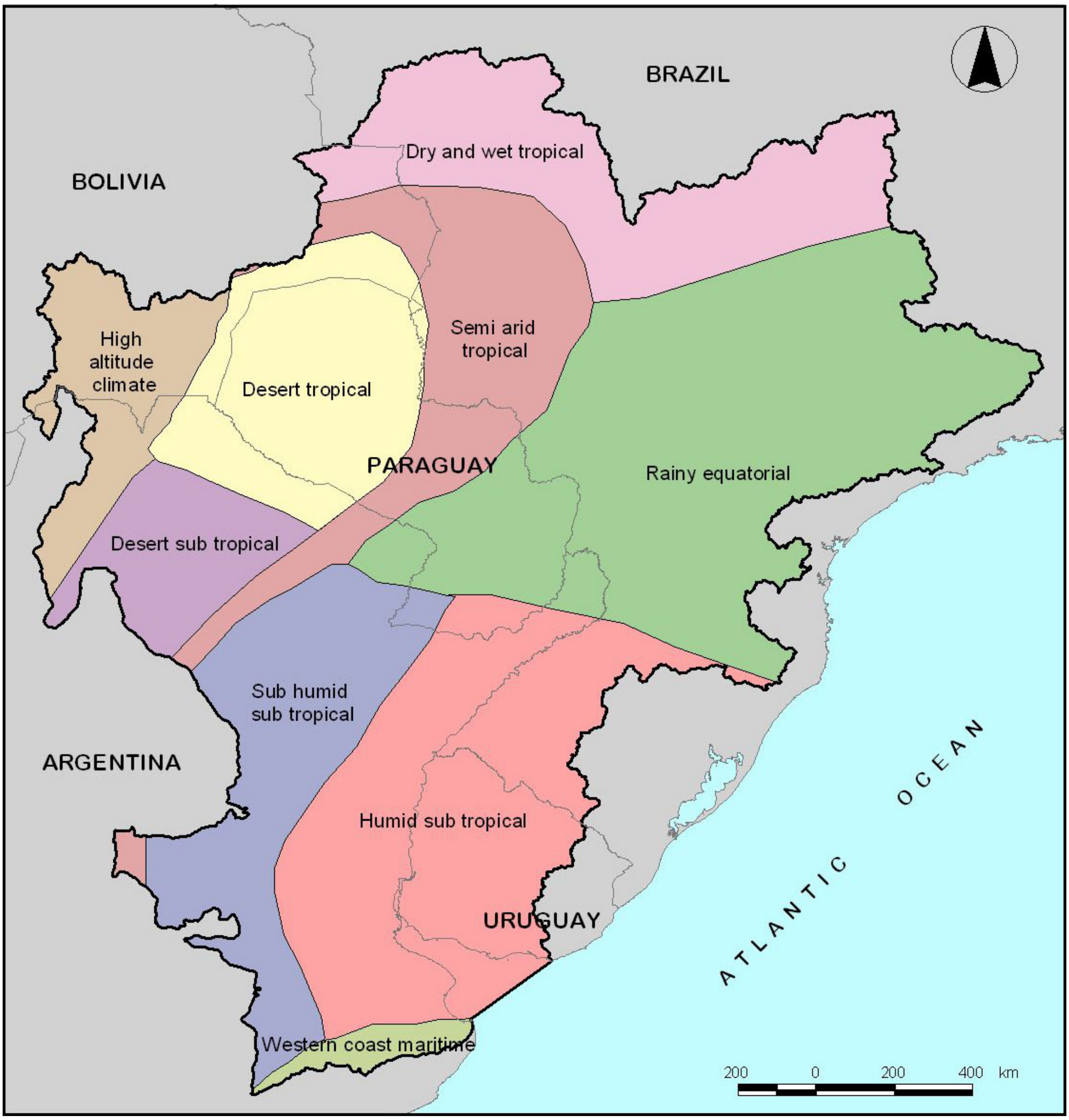
2.2.1. Dominant Climate Types

Rainy equatorial climate occupies a broad area in Brazil and eastern Paraguay (see Map 2.2); the main climate feature of this type is the large annual precipitation (over 2,000 mm) and practically no dry season.

Tropical climate type is located in the western and northern sectors of the La Plata Basin and includes several sub-types according to variations of precipitation (wet and dry, semi arid and desert). The dominant climatic features in the northern area (Brazilian Plateau) are the occurrence of heavy rainfall (showers) in summer and a relatively drier season in winter, with reduced rainfall (ANEEL, 1999).

Sub-tropical humid climate, occupies the southern part of Paraguay, Uruguay, the Paraná delta and the Argentinean margin of the La Plata River, and south of Brazil. Rainfall in this area is regular all the year round (ANEEL, 1999).

Map 2.2. La Plata River Basin. Climate



Source: Modified from Strahler & Strahler, 1989

Sub-humid climate prevails along the lower Paraná-Paraguay Basin and in the rainier pre-Andean zone. It is a transition climate type, with maximum rainfall in autumn. Finally, the high altitude climate is found in the Andes ranges (ANEEL, 1999).

2.2.2. General Climatic Characteristics

2.2.2.1. Precipitation

Mean annual total precipitation in the La Plata Basin is about 1,100 mm, only about 20% (23,000 m^3/s) of which reaches the sea as surface water. The other 80% is evaporated and infiltrated into the ground. It is apparent that any percentage change in the evaporation and infiltration rate may lead to greater percentage changes in the runoff. Consequently, due to changes in vegetation cover in most of the middle and upper Paraná, in the middle and lower Paraguay, and in the upper Uruguay basins, human activities in the last 50 years may have led to changes in runoff. Dams could also alter evaporation, though probably at a lower rate (Baetghen *et al.*, 2001).

Mean annual rainfall in the La Plata Basin tends to decrease both from north to south and from east to west. Corresponding amounts range from 1,800 mm in the maritime uplands along the Brazilian coast to 200 mm along the western boundary of the basin. Rainfall is heavy in the upper stretches of the Paraguay and Paraná River basins. The amplitude of the annual cycle in rainfall decreases from north to south. The northern part of the basin has a well-defined annual cycle with maximum precipitation during summer (December-February). The central region (northeastern Argentina/southern Brazil) has a more uniform seasonal distribution, the maximum being during spring and autumn. Since the major rivers in the basin generally run from north to south, this rainfall regime contributes to the attenuation of the seasonal cycle downstream (Baetghen *et al.*, 2001).

2.2.2.2. Temperature

The mean annual temperature in the basin ranges from around 15°C in the south to more than 25°C in the northwest. Most locations east of the Andes less than 800 km from the ocean have a mean annual temperature below 20°C. The higher altitudes in the eastern part of the Brazilian States of São Paulo, Paraná and Santa Catarina are substantially cooler than their surroundings (Baetghen *et al.*, 2001).

In winter, mean monthly temperatures have a clear north-south gradient. In July, for example, the mean temperature over the northwestern part of the basin is over 20°C, while that in the province of Buenos Aires is around 10°C cooler. In summer the gradient is more zonal, reacting to the land ocean distribution. In January, maximum mean temperatures are over 27.5°C in the Chaco and western Argentina, while they are below 22.5°C in the coastal areas of southern Brazil, Uruguay and the Province of Buenos Aires (Hoffmann, 1975; Baetghen *et al.*, 2001).

2.2.3. Observed Climatic Variation and Long-Term Projections

2.2.3.1. Mesoscale, synoptic and interannual variability

The atmospheric water cycle of the La Plata Basin is significantly influenced by <u>mesoscale variability</u> associated with the northerly/north-easterly low-level jet east of the Andes. This low-level jet has a diurnal cycle with a night-time maximum that favours increased moisture flux convergence in the La Plata Basin. This convergence, in turn, is associated with generalised night-time ascent and precipitation. A second precipitation regime is found toward the eastern part of the basin, where higher values during daytime appear to be associated with a convectively unstable atmosphere, convection being triggered by a sea breeze enhanced by the topography of southern Brazil (Baetghen *et al.*, 2001).

Variability in precipitation at synoptic scale is primarily associated with extra-tropical cyclones, since the south-western Atlantic Ocean just off the South American coast between 30° S and 45° S is one of the regions with the highest cyclogenetic activity in the Southern Hemisphere. Eastward travelling cyclonic systems that develop over the ocean can intensify after reaching the continent and follow trajectories along the coast. Sea surface temperature gradients can have a significant influence on the trajectories of these cyclones and their associated sensible and latent surface heat fluxes. Frontal systems move rapidly over land regions of low specific humidity and high loss of heat by radiation, and are not generally associated with strong convective activity. Cold surges (known as "friagems" in Brazil), can reach as north as central and southern Brazil, and have important economic consequences (Baetghen *et al.*, 2001).

Synoptic scale waves move across the basin. Due to cyclonic disturbances, the low-level perturbation intensifies at around 1,000 km east of the Andes Mountains. Increases in rainfall are associated with an increased contribution of moisture from the tropics along the eastern flank of the Andes Mountains, and positive anomalies of the atmospheric column water content (Baetghen *et al.*, 2001).

Finally, the main source of interannual variability in the La Plata Basin is the ENSO (El Niño-Southern Oscillation), which has two extreme phases known as "El Niño" and "La Niña" (Barros *et al.*, 2004). Several studies have found links between ENSO events in the equatorial Pacific Ocean and rainfall anomalies during late austral spring-early summer and late austral autumn-early winter in extra-tropical South America. Rainfall anomalies in north-eastern Argentina, south-eastern Brazil and Uruguay tend to be positive from November of El Niño years to February of the following years, and negative from July to December of La Niña years. In the same area but also in Paraguay, a positive and significant difference in spring precipitation between El Niño and La Niña is observed (Baetghen *et al.*, 2001).

There are also detailed studies on the interannual response of precipitation to the warm and cold phases of ENSO in some regions of the La Plata Basin. Precipitation correlates significantly with ENSO indexes during austral spring in the south of Brazil with similar signals during the winter. In Uruguay and southern Brazil, rainfall tends to be higher than average in El Niño years, especially during November-January. These precipitation anomalies during ENSO events are associated with atmospheric circulation anomalies. Over most of south-eastern South America, in spring, during warm (cold) ENSO events, the subtropical jet and cyclonic activity are enhanced (weakened). During most warm (cold) ENSO events, the Chaco low deepens (weakens) and moisture advection from the north increases (Baetghen *et al.*, 2001).

2.2.3.2. Decadal Variability and Trends

Rainfall variability in most of southern South America has important interdecadal components. The strongest interdecadal variability in the annual cycle of precipitation occurs in regions of transition between precipitation regimes, especially in the Paraná River Basin. In subtropical Argentina, annual precipitation also shows oscillations with periods from 7 to 10 years. On this time scale, there is a close relationship between temperature and precipitation regimes (Baetghen *et al.*, 2001).

Precipitation trends in Argentina have been positive since 1916 and even increased after the late fifties. This behaviour is consistent with a climatic jump around the 1960s, when the southern portion of South America experienced significant warming. Precipitation increased by up to 30% between 1956 and 1991 in several localities between 20° S and 35° S east of the Andes. In a large part of this region, most of the increase occurred during the 1960s, and it seems to have been associated with a reduction of the meridional gradient of surface temperature, which probably caused a southward shift of regional circulation. Consistently, the leading principal component of annual precipitation correlates with the meridional gradient of temperature at interannual as well as interdecadal timescales (Baetghen *et al.*, 2001).

Another strong precipitation increase was observed during the late 1970s, which correlates with an increase in the subtropical temperature of the Southern Hemisphere. The positive trend in precipitation during 1956-1991 has facilitated a southward extension of the agricultural frontier in Argentina, increasing available lands by the 1960s in an amount that exceeds 100,000 km^2 (Baetghen *et al.*, 2001).

Trends in precipitation over the basin prior to the 1960s have also been detected. A linear trend has been reported in the monthly and annual rainfall in part of the province of Buenos Aires (Argentina). Decreased precipitation in subtropical Argentina tends to be associated with enhanced westerly flow in Patagonia. The negative trend in the subtropical region in the 1931-50 period could be associated with a slowing of the westerlies over Patagonia. Significant negative correlations have been obtained between westerly flow and rainfall in eastern Argentina (Baetghen *et al.*, 2001).

As regards future tendencies, the magnitude of the changes in precipitation over recent decades as well as the advantages and disadvantages associated with such changes have been significant. The question then naturally arises about whether these new conditions will remain or intensify over the next few decades or whether the previous conditions will return. The possible connection between these tendencies and the Climate Change going on as a consequence of greenhouse-effect gas emissions would be very helpful in answering this question, because this change will continue in the same direction over the next few decades. Establishing this connection would therefore lead to drawing conclusions on the timescale in which new conditions would persist and on the sign of potential future trends (Barros *et al.*, 2004).

2.2.4. Hydrological Influence of Climate Change on Snow and Ice Cover

There is no specific information about the influence of climatic change on snow and ice cover in the La Plata Basin. Nevertheless, various areas of the Andes Mountains are being impacted by changes probably related with climate change. These changes would be important in the basin, since some of the rivers (Bermejo, Pilcomayo) have their springs in that range.

According to the last IPCC report (2001), the scenarios of climate change for Latin America mountain areas are highly uncertain, since available General Circulation Models (GCMs) do not provide sufficiently accurate local predictions. It is observed that glacial retreat is under way in various parts of the Andes and in the ice fields on the southern tip of the continent (Mata & Campos, 2001).

A significant temperature increase has been observed in many Andes regions, such as in the Bolivian Andes. In the Argentinean Andes, the situation is more diverse: precipitation increases to the north, on the border with Bolivia, and decreases in the south (Great Ice, 2004).

Regarding precipitation, paleoclimatic records suggest an increase in precipitation at high elevations in north-western Argentina, during the past 200 years. In the same region, as well as in Bolivia and south-eastern Peru, records show that 17th-century climate was wetter and less variable (fewer floods and droughts), whereas 18th-century climate was highly unstable, with a large amplitude in the annual cycle and recurrent wet and dry periods (Mata & Campos, 2001).

Between 20º and 38º S, rainfall around the Andes Mountains occurs mainly during summer. In the Altiplano[3], these summer rains are related to the monsoon flow from the Atlantic, meanwhile precipitation in the dry season (winter), is associated with particular synoptic situations. The reproduction of this phenomenon may have had a marked influence on glacier balances in the past; that is why changes in seasonal precipitation would influence glacier balances in the future (Great Ice, 2004).

Glacier flows have increased significantly since the 1970s, as in the specific case of some areas outside the La Plata Basin (e. g., Blanca Range, Peru). According to IPCC scenarios, flows will continue increasing in the future, until an uncertain date, after which they will decline again. This date strongly depends on the rate of glaciations in each of the glacier basins (Great Ice, 2004).

2.2.5. Regional Changes in Climatic Conditions in Arid and Semi-Arid Zones

Some changes in climate conditions were observed in arid and semi-arid zones of the La Plata Basin. The increase in mean annual precipitation over the whole region involved the movement of isohyets to the west of arid subtropical Argentina. The 600-mm isohyet, which approximately demarcates the agricultural border on the west of the Argentinean Humid Pampas, moved over 200 km in the south, and the 800-mm one, over 100 km in the north, in the Chaco region (Barros *et al.*, 2004).

Climate models show precipitation changes caused by the greenhouse effect. In summer, the semi-arid zone located in western Argentina would experience a 10% decrease in precipitation for each degree that the average global temperature increased. In winter, models show precipitation increases of 5% in the austral zone and 5-10% in north-eastern Argentina, as a probable result of global warming (UNEP, 2004).

Changes in precipitation projected under a set of climate scenarios assembled for sensitivity studies in the IPCC Second Assessment Report (e.g., a 25% increase in the present mean of 2 mm/yr rainfall) are unlikely to produce major ecosystem changes in arid and semi arid areas, since these systems already experience wide fluctuations in rainfall and are adapted to coping with the consequences of extreme conditions. Regarding changes in temperature, increases projected in the scenarios are typically in the range of 0.5-2.0ºC, with greater increases in

[3] The “Altiplano” or “Puna” is a 3,000 m high plain, located in the Central Andes region. It comprises the north of Chile, the western area of Bolivia, the centre and south of Peru and the northwest of Argentina.

summer. A rise of 2ºC without an increase in precipitation would increase potential evapotranspiration by 0.2-2 mm per day (Canziani & Díaz, 1997).

2.3. Land Use in the La Plata Basin

2.3.1. Agriculture and Livestock

Agriculture is the main land activity in the basin. Argentina has a percentage of 12.8% of arable land, which represents 35,000,000 ha of its national territory. This is the higher percentage, followed by Brazil, Paraguay and Uruguay. Table 2.1 shows the total arable and non arable lands, and their percentages over total surface area. Table 2.2 shows the distribution of agricultural area devoted to permanent crops and pasture, by country.

Table 2.1. La Plata River Basin. Arable and non-arable lands by country

Countries	Land Area (10^3 ha)	Arable & Permanent Crops		Non-Arable & Non-Permanent*	
		Total	% over Land Area	Total	% over Land Area
Argentina	273,669	35,000	12.8	238,669	87.2
Bolivia	108,438	3,106	2.9	105,332	97.1
Brazil	845,942	66,580	7.9	779,362	92.1
Paraguay	39,730	3,115	7.8	36,615	92.2
Uruguay	17,502	1,340	7.7	16,162	92.3

* Includes lands with permanent pastures.
Source: FAO, 2004

Table 2.2. La Plata River Basin. Percentage distribution of the agricultural area by country

Countries	Agricultural Area* (10^3 ha)	Arable & permanent crops (%)		Permanent Pasture (%)
		Arable Land (%)	Permanent Crops (%)	
Argentina	177,000	19.0	0.8	80.2
Bolivia	36,937	7.9	0.5	91.6
Brazil	263,580	22.4	2.9	74.7
Paraguay	24,815	12.2	0.4	87.4
Uruguay	14,883	8.7	0.3	91.0

* Includes both agriculture (arable and permanent crops) and cattle-raising activities (permanent pastures)
Source: FAO, 2004.

Characteristics of agriculture and livestock by country show that the Argentinean provinces[4] integrating the basin produce over 90% of the country's cereals and oilseeds, maintain 70% of their bovine stock, generate over 60% of the country's GDP, and are one of the largest food-

[4] See the "Methodological note" in section 2.4 of this chapter.

producing areas in the world. Other crops in the basin are: cotton, tobacco, beans, sugarcane, citrus fruits and rice (Mugetti, 2004).

By the end of the 1960s, a gradual expansion of the farming border and changes in the main crops were recorded in the Argentinean sector of the basin. By this time, the main rural areas changed crop and agricultural systems. In the late 1960s, the annual wheat crop was substituted by a wheat and soybean rotation system (UNEP, 2004).

In Bolivia, the commercial agricultural sector seats on the area tributary to the Amazon and the La Plata rivers. Agricultural and livestock exploitation is carried out on large plots and with high exporting expectations (Matos & Crespo, 2000).

In the Brazilian sector of the Uruguay River Basin, subsistence crops and livestock and poultry-keeping practices alternate with soybean, millet, wheat and rice crops, depending on soil characteristics. Rice cultivation is the activity with the highest water demand in the area. In the Paraguay Basin (also in Brazilian territory), the land use is changing rapidly owing to the clearing, extension of the agricultural frontier –due to soybean cultivation– and livestock exploitation. These processes occur in the Planalto (Brazilian plateau) and in the Pantanal, although, in the latter, conservation priorities keep it as a frontier for the future. Finally, in the Paraná Basin, use for grazing involves around 57% of agricultural and livestock lands, while 23% is under cultivation; the remaining area corresponds to native forest. The main agricultural and livestock activities are cattle-raising and orange, soybean, sugarcane and coffee crops (Dias Coelho, 2004). It is important to point out that about 10% of the country's bovines are raised in the La Plata Basin (UNEP, 2004).

In the late 1960s, expansion of agricultural border and changes in land use were registered in Southern Brazil. Until 1970, most of the Paraná State and a large part of the São Paulo State cultivation areas were used for coffee. Large areas of these plantations were destroyed by fire, causing major financial losses. Subsequently, annual crops such as corn and soybean replaced coffee (UNEP, 2004).

In Paraguay, agriculture takes up especially the eastern region of the country, with a higher participation of mechanised activities. Cultivated pastures cover an area that has experienced considerable variation over the past years due to the change in land use (Monte Domecq, 2004). The pastures generally occupy deep, well-drained soils of the slopes and are devoted to cattle fattening, whereas low floodable fields are mostly devoted to cattle breeding. Soybean cultivation is increasing, due to application of new technologies and the expansion of productive areas (UNEP, 2004). On the other hand, agriculture in the Paraguayan Chaco region has remained stable, even decreasing its area in comparison to previous years, mainly due to the great livestock expansion in the central Chaco and the frequent droughts over recent years. The agricultural area could increase over the next few years owing to sesame cultivation (Monte Domecq, 2004).

The agricultural and livestock land uses in Uruguay are expressed in the existence of crops, animal stock, plantations, and natural field, with a distribution by regions that presents differences over time. Several agricultural and livestock regions are identified in the country, depending on the combination of activities –predominantly agricultural, milk and livestock, livestock on natural field, cattle-raising with intensive improvements, horticulture and fruit-growing, and predominantly milk– (Genta *et al.*, 2004). Wheat, barley, rice and oats are the main crops; the 80% of total Uruguayan bovine are raised in the La Plata Basin (UNEP, 2004).

2.3.2. Forestry

Forest resources are important in the area covering the south of Brazil, the east of Paraguay and the northeast of Argentina, where they are both richer and more exploited. In addition, there are large areas in Paraguay, the east of Bolivia and the west of Brazil, where the potential for development has not been well determined yet. The pressure for the search of new lands for agriculture, the demand for certain types of wood, and the clearing and burning vegetation practice have led to a severe deforestation problem. All the countries in the basin have carried out studies on forest plantations and started reforestation programs (CIC, 2005).

In the eastern region of Paraguay, forest activity uses land depending on whether there are native forests in it to be exploited. In the western region, forest products such as logs and charcoal are obtained; in this area, the extraction of woods with commercial value, such as “palosanto” (*Bulnesia sarmientoi*), has had a considerable increase (Monte Domecq, 2004).

In Uruguay, artificial forests are associated to cattle-raising production, which requires forests with protection and shade in natural grasslands. Many varieties of eucalyptus were mainly planted, which were integrated into the rural landscape as spots and blow-out screens. Current use of the native forest includes cattle grazing and selective wood extraction. Such wood is used as posts and firewood to support the agricultural and livestock system. Over the past few years, the State has favoured forest activity with fiscal and financial incentives. A new export market for lumber and raw-material for the paper industry have appeared (OEA-BID-ROU, 1992).

2.3.3. Industry

In the La Plata Basin industries are generally associated with the transformation of agricultural products. In Argentina, the major industrial districts are located in the provinces of Buenos Aires and Santa Fe, and in Buenos Aires City. This is a significant sector, especially related to agricultural and livestock raw materials, such as tanneries, foods, beverages and milk (Mugetti, 2004). The same happens in Uruguay, where the agricultural food industry is settled in the departments, while the rest of the activity concentrates in the Montevideo Metropolitan Area (Genta *et al*., 2004). In Bolivia, a large part of the industry transforms agricultural and organic materials in end products (Mattos & Crespo, 2000).

In Brazil, the largest industrial concentration lies in the southeastern and southern regions. The largest industrial sector is much diversified (computers, food, agricultural, textile) and it is mostly located in the Paraná Basin. Food and agricultural production are located mainly in the Uruguay and Paraguay basins (Dias Coelho, 2004).

2.3.4. Settlements

Historically, the Argentinean area of the La Plata Basin has been the most densely populated in the country; at the beginning of 2000’s this area concentrates over 50% of the country’s population. Buenos Aires City (Federal District and Capital city) was a location factor for the large concentration of industrial development in the La Plata River fluvial front and the lower course of the Paraná River. The urbanisation process reached its highest intensity first in the provinces of Buenos Aires, Santa Fe and Entre Ríos, later extending to Córdoba and Tucumán, as well as other regions. The urban development is dominated by the axis formed by the Great Rosario, the Buenos Aires Metropolitan Area and the Great La Plata, located at the final sector of the basin. Meanwhile, the north-eastern area is polarised by the Resistencia-Corrientes urban axis (Mugetti, 2004).

The Brazilian sector of the basin also concentrates the largest urban areas of the country, such as São Paulo and Curitiba. On the other hand, the number of middle-sized cities has been growing as a consequence of migration from big cities (Dias Coelho, 2004).

In Paraguay, the biggest urban concentration is located in the eastern region, where the main urban settlement and capital city –Asunción– is located. In this region, the construction of the Itaipú dam (shared by Paraguay and Brazil) led to an expansion of the road network and the advancement of the agricultural frontier, together with an urbanisation process. Meanwhile, in the western region human settlements are smaller and more disperse (Monte Domecq, 2004).

Finally, the Uruguay population inhabiting the La Plata Basin represents a 93% of the overall population. They concentrate primarily in the cities located on the Uruguay and the La Plata rivers littorals. The main services in the country are tourism and financial activities, as well as those activities developed around the demand from families and governmental institutions. The latter have a relatively homogeneous distribution, whereas the financial sector and tourism services concentrate in the southern area, especially in Montevideo, Colonia and Maldonado departments.

2.4. Major Socioeconomic Characteristics of the La Plata Basin

Major socioeconomic characteristics of the riparian countries are described using statistical information provided by official institutions, later analysed following several methodological steps which are described in Annex I.

2.4.1. Demography

2.4.1.1. Population

The total population in the basin amounts to 100,852,919, at the first half of the 2000s, when there was also a 10.8 % growth with respect to the 1990s. The distribution of total population by country is presented in Table 2.3, which also shows the composition of the population by gender and the intercensus growth rates.

Comparing the intercensus growth of each country and their jurisdictions, it is clear that the most significant growth was recorded in Paraguay. Argentina and Brazil have had similar growth rates, followed by Uruguay. Finally, Bolivia had the lowest population growth in the basin.

Table 2.3. La Plata River Basin. Total population in the early 2000s

Countries	Total Population*	Male	Female	Intercensus Growth (%)
Argentina**	26,274,861	12,772,061	13,502,800	10.0
Bolivia***	1,718,908	848,085	866,823	2.1
Brazil****	65,455,629	31,813,496	33,642,133	9.2
Paraguay	5,163,598	2,603,242	2,559,956	24.3
Uruguay*****	3,043,969	1,472,848	1,571,121	7.1

Note: * Last registered data: Argentina & Bolivia, 2001; Brazil, 2000; Paraguay, 2002; Uruguay, 2004.
** Provinces and departments included in the basin.
*** Departments and provinces included in the basin.
**** States and municipalities included in the basin.
*****Departments included in the basin.
Sources: INDEC, 2001; INE, 2001 a; IBGE, 2000; DGEEC, 2002; INE, 2005 a.

Population in La Plata Basin lives mainly in urban areas. During the first half of the 2000s, 87,542,614 have lived in cities, constituting an 86.8% of total population. Argentina, Uruguay and Brazil are the three countries with the highest percentages of population living in cities (Table 2.4).

The large urbanisation rates are fundamentally explained by the existence of an important number of cities with over 100,000 inhabitants, including the five national capitals: Buenos Aires (capital city of Argentina), Sucre (capital city of Bolivia), Brasilia (capital city of Brazil), Asunción (capital city of Paraguay) and Montevideo (capital city of Uruguay). This group includes some cities which greatly exceed 1,000,000 inhabitants, and even 10,000,000, as are the cases of the São Paulo Metropolitan Area (over 17,000,000 inhabitants) and the Buenos Aires Metropolitan Area (over 14,000,000 inhabitants). Table 2.15 provides a non-exhaustive list of cities with over 100,000 inhabitants.

Table 2.4. La Plata River Basin. Total urban population and urbanisation rate (early 2000s)

Countries	Urban Population*	Urbanisation Rate (%)
Argentina	23,847,273	90.8
Bolivia	762,251	44.3
Brazil	57,173,522	87.3
Paraguay	2,928,958	56.7
Uruguay	2,767,419	90.9

Note: *Last registered data: Argentina & Bolivia, 2001; Brazil, 2000; Paraguay, 2002; Uruguay, 1996
Sources: INDEC, 2001; INE, 2001 a; IBGE, 2000; DGEEC, 2002; INE, 2005 a.

Table 2.5. La Plata River Basin. Main cities of the basin in the early 2000s (> 100,000 inhabitants)

City	Country	State / Province / Department	Last Registered Population
São Paulo Metropolitan Area	Brazil	São Paulo	17,878,703
Buenos Aires Metropolitan Area*	Argentina	Buenos Aires City-Buenos Aires Province	14,236,713
Curitiba Metropolitan Area	Brazil	Paraná	2,726,556
Campinas	Brazil	São Paulo	2,338,148
Brasilia**	Brazil	Federal District	2,051,146
Goiânia Metropolitan Area	Brazil	Goias	1,639,516
Montevideo**	Uruguay	Montevideo	1,269,552
Great Rosario	Argentina	Santa Fe	1,161,188
Great La Plata	Argentina	Buenos Aires	694,253
Campo Grande	Brazil	Mato Grosso do Sul	663,621
Londrina	Brazil	Paraná	647,854
Asunción**	Paraguay	Asunción	513,399
Ribeirão Preto	Brazil	São Paulo	504,923
Uberlândia	Brazil	Mato Grosso	501,214
Cuiabá	Brazil	Mato Grosso	483,346
Maringá	Brazil	Paraná	474,202
Salta	Argentina	Salta	468,583
Great Santa Fe	Argentina	Santa Fe	454,238
Great Resistencia	Argentina	Chaco	359,590
São Jose do Rio Preto	Brazil	São Paulo	358,523
Corrientes	Argentina	Corrientes	316,782
Bauru	Brazil	São Paulo	316,064
Posadas	Argentina	Misiones	279,961
Ponta Grossa	Brazil	Paraná	273,616
Paraná	Argentina	Entre Ríos	247,310
Santa María	Brazil	Rio Grande do Sul	243,611
Ciudad del Este	Paraguay	Alto Paraná	223,350
Formosa	Argentina	Formosa	198,074
Sucre**	Bolivia	Chuquisaca	193,876
Dourados	Brazil	Mato Grosso do Sul	164,949
Rondonópolis	Brazil	Mato Grosso	150,227
Coronel Oviedo	Paraguay	Caaguazú	141,975
Villa María-Villa Nueva	Argentina	Córdoba	149,303
Potosí	Bolivia	Potosí	145,157
Concordia	Argentina	Entre Ríos	138,099
Tarija	Bolivia	Tarija	135,783
Poços de Caldas	Brazil	Mato Grosso	135,627
San Nicolás de los Arroyos	Argentina	Buenos Aires	119,302
Bagé	Brazil	Rio Grande do Sul	118,767

(*) Including Buenos Aires City (capital city of Argentina), with 2,776,138 inhabitants.
(**) National capitals
Sources: INDEC, 2001; INE, 2001 a; IBGE, 2000; DGEEC, 2002; INE, 2004.

Migration movements have had a central importance in the early stages of basin's peopling. In these first stages (from 19th-century and early 20th-century) population came from Europe mainly. Since the second half of 20th-century internal migration has become more relevant than the international one; theses processes were led mainly by domestic rural migrants who generally settle in large urban areas looking for better living conditions. Migration movements among the countries were also important, mainly from Paraguay and Bolivia to Argentina and Brazil. Nevertheless, at the beginning of 2000s internal migration was still more important than international migration, as Table 2.6 shows.

Table 2.6. La Plata River Basin. Migration (internal and international) in the early 2000s, by country.

Countries	Total Population	Born Outside the Jurisdiction			
		In the Country	%	Foreigners	%
Argentina*	26,274,861	1,018,211	3.5	414,269	1.4
Bolivia	1,718,908	525,8393	30.6	29,906	1.7
Brazil	64,563,920	15,363,584	23.8	420,051	0.7
Paraguay	5,163,598	n/a	n/a	201,655	3.9
Uruguay	3,043,969	690,448	22.7	90,809	3.0

Note: * Population aged 5 and more for the entire provinces of the La Plata Basin
n/a: Not available
Sources: INDEC, 2001; INE, 2001 a; IBGE, 2000; DGEEC, 2002; INE, 1996.

2.4.1.2. Living Standard and Economic Activities

The Human Development Index (HDI) is a useful tool to assess the living standards of given countries, since it is synthesis of the various dimensions forming such a development[5]. Table 2.7 shows the HDI and its indicators in the five riparian countries of the La Plata Basin, in 2002.

Argentina (#34) and Uruguay (#46) are ranked among the countries with a high degree of human development, whereas Brazil, Paraguay and Bolivia are in the group of intermediate human development countries[6]. Considering the three indexes of HDI (long and healthy life, knowledge and standard living) education was the factor determining the HDI value in all the countries.

On the other side, several indicators show the situation of poverty in the La Plata Basin; they are percentages of poor and indigent households[7], daily income and poverty line[8]. They all describe situations of poverty owing to low/insufficient/none income. Table 2.8 shows the

[5] The HDI measures the average achievements in a country in three basic dimensions of human development: (1) a long and healthy life, as measured by life expectancy at birth; (2) knowledge, as measured by the adult literacy rate and combined primary, secondary and tertiary gross enrolment rate; (3) a decent standard of living, measured by GDP per capita (UNDP, 2004).
[6] Since the HDI has been obtained with data from 2002 and earlier, the position of the countries in the HDI world ranking should be changed owing to the strong economic and political crises that the countries have gone through between 2002 and 2003.
[7] Poor households are those with an income below the double of the cost of a basic food basket. Indigent households are those with an income below the cost of a basic food basket (CEPAL, 2004 b).
[8] The poverty line describes the capacity to meet, by means of the purchase of goods and services, a set of food and non-food basic requirements considered to be essential, such as clothing, transportation, education, health (INDEC, 2005).

percentage of population below poverty line and table 2.9 the percentage of poor and indigent households, by country.

Table 2.7. La Plata River Basin. Human Development Index by country (2002)

HDI Indicators and Indexes	Argentina	Bolivia	Brazil	Paraguay	Uruguay
Life Expectancy at Birth (years) 2002	74.1	63.7	68.0	70.7	75.2
Adult Literacy Rate (% ages 15 and above) 2002	97.0	86.7	86.4	91.6	97.7
Combined Gross Enrolment Ratio for Primary, Secondary and Tertiary Schools (%) 2001-2002	94	86	92	72	85
GDP per Capita (PPP* USD) 2002	10,880	2,460	7,770	4,610	7,830
Life Expectancy Index	0.82	0.64	0.72	0.76	0.84
Education Index	0.96	0.86	0.88	0.85	0.94
GDP Index	0.78	0.53	0.73	0.64	0.73
HDI Index	**0.867**	**0.681**	**0.775**	**0.751**	**0.833**
HDI Rank	*34*	*114*	*72*	*89*	*46*

Note: * PPP Purchasing Power Parity
Source: UNDP, 2004.

The data presented in the tables show the relevance of poverty and extreme poverty (measured as indigence) in the riparian countries. Percentages are very high in most of the countries, meanwhile differences can be observed between urban and rural households. In the latter, the relative weight of poverty is much higher.

Table 2.8. La Plata River Basin. Population below poverty line (%) by country. Years 1990-2000

Countries	Population Below Poverty Line (%)		
	$ 1 a day	$ 2 a day	National Poverty Line
Argentina	3.33	14.31	40.2*
Bolivia	14.38	34.33	62.7
Brazil	8.17	22.43	17.4
Paraguay	14.86	30.29	21.8
Uruguay	< 2	3.85	----

Note: * Second semester of 2004 in 28 urban areas of Argentina
Sources: UNDP, 2004; INDEC, 2005.

Uruguay has the best situation related to poverty, with very low percentages of population living in poor and indigent households –even though data for rural households are unknown[9]– as well as low percentage of population living under the poverty line.

Another good indicator of living standards (both social and economic) in a given country is the employment status. Periodic measurements of this indicator in the riparian countries of the La Plata Basin generally refer to urban areas. The latest data available indicate that the employment rate ranges between 40% and 92% (see Figure 2.1).

Table 2.9. La Plata River Basin. Poor and indigent households (urban and rural) by country. Years 2000-2001

Countries	Poor Households (%)			Indigent Households (%)		
	Total	Urban	Rural	Total	Urban	Rural
Argentina*	---	35	---	---	14	---
Bolivia*	56	45	73	32	17	56
Brazil**	30	27	45	10	8	21
Paraguay**	52	42	65	27	15	41
Uruguay*	---	9	---	---	1	---

Note: * Data of year 2002; ** Data of year 2001
Source: CEPAL, 2004 a

As regards employment structure, the population is mostly employed in commerce and services sectors, with percentages varying between 50% and 60% of the total employed population. Another relevant sector is the manufacturing industry, engaging between 12% and 18% of the total employed population, following by financial services, transportation and construction (CEPAL, 2004 b).

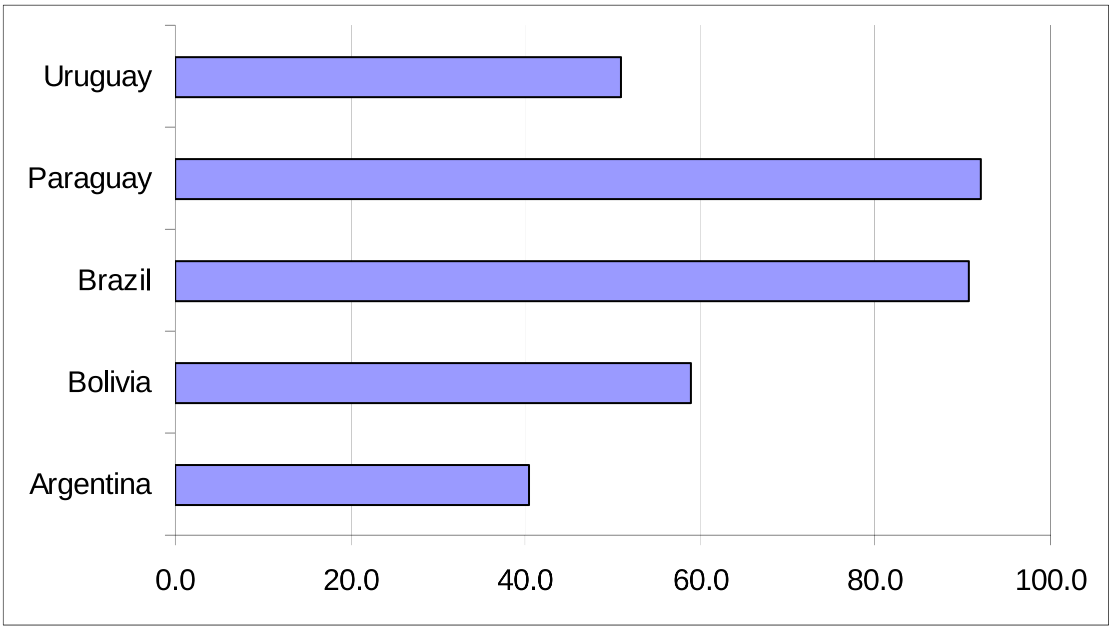
Unemployment rate is both an indicator of employment status as well as an indicator of poor social and economic conditions. Figure 2.2 shows the evolution of annual urban unemployment rate in the late 1990s and the early 2000s (data provided by CEPAL) and the latest data available for the riparian countries (data provided by the statistics agencies in each country).

A continuous growth of unemployment rates in urban areas was observed between the late 1990s and the beginning of 2000s. This growing trend appears to be reverting, since the last data available point to a marked fall in the unemployment rate, with differences ranging between a maximum of over 7 points in Argentina and a minimum of over 2 points in Brazil.

Differences between gender are observed in unemployment status (see Figure 2.3), being the unemployment rate for females higher than for males. This difference increases substantially in the case of Uruguay (nearly 8 points).

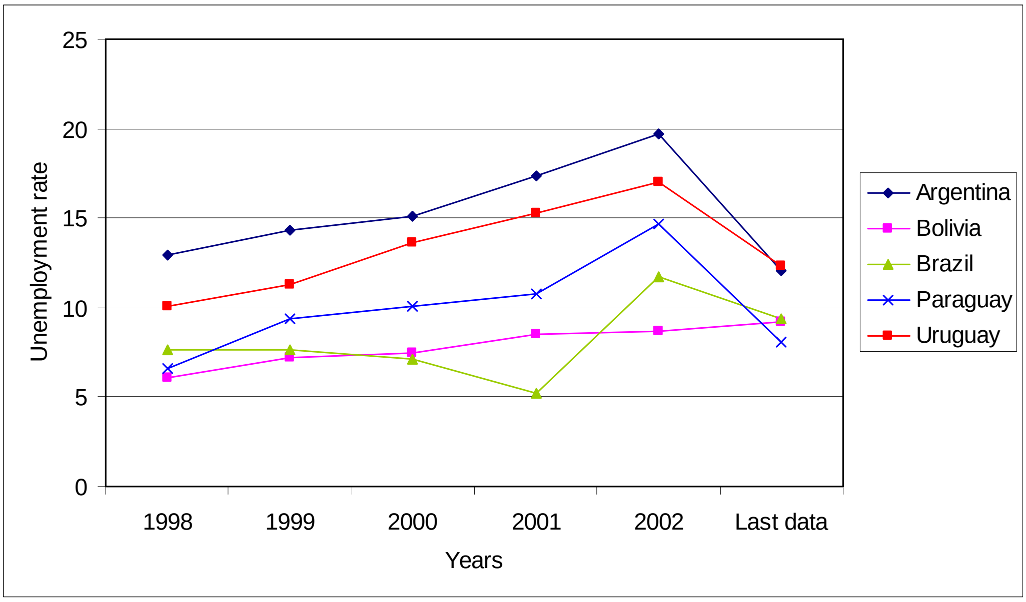
[9] The measurement of poor and indigent household as well as population below poverty line is made only in major urban centres.

Figure 2.1. La Plata River Basin. Employment rate (%) by country (early 2000s).



Source: INDEC, 2005; INE, 2004; IBGE, 2005 a; DGEEC, 2003 b; INE, 2005 b

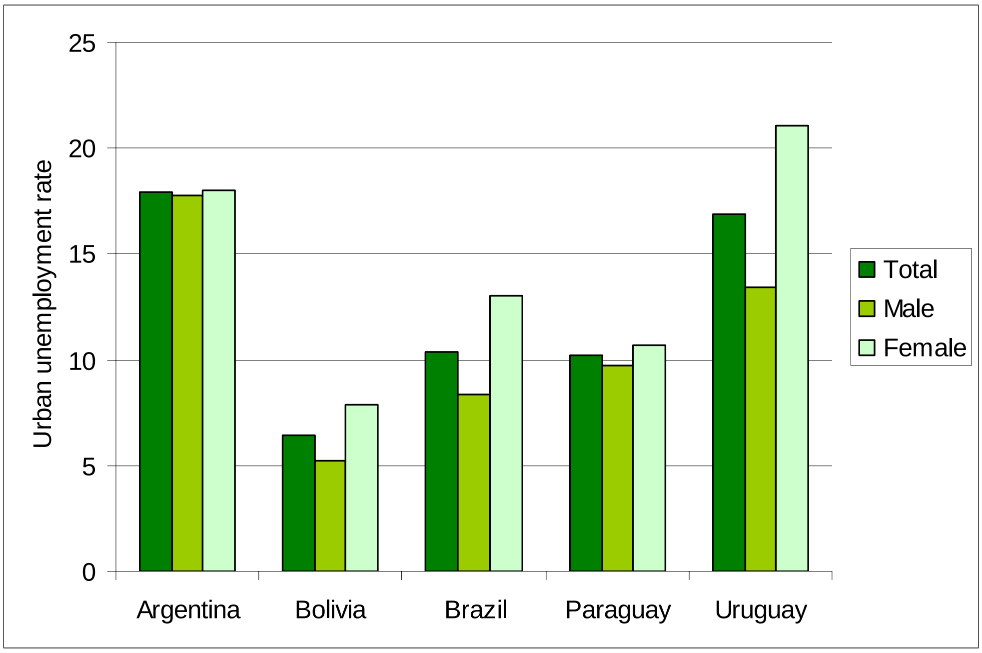
Figure 2.2. La Plata River Basin. Evolution of urban unemployment rate by country (1998-2002)



Note: Last registered data: Argentina, April-June 2005 (25 urban areas); Brazil, July 2005 (6 metropolitan areas); Uruguay, April-June 2005 (cities with 5,000 or more inhabitants)
Source: CEPAL, 2004 a; INDEC, 2005; INE, 2004; IBGE, 2005 a; DGEEC, 2003 b; INE, 2005 b

The total and per capita gross domestic product (GDP) accounts for the degree of economic development obtained by the countries and the theoretical product distribution among the inhabitants (see Table 2.10). In the early 2000s, the domestic economies of the countries of the La Plata Basin have gone through profound economic and political crises, characterised by big changes which have usually resulted in generalised falls of the main economic variables. The recent evolution of GDP is observed in Figure 2.4, which shows the significant variations that took place in the riparian countries as a result of those economic and political crises.

Figure 2.3. La Plata River Basin. Urban open unemployment rate by gender and country (2002)



Source: CEPAL, 2004 a

After the significant falling in GDP, the year 2003 marked the beginning of a process of slow recovery in this indicator. Estimates published by CEPAL reveal that, over the first half of 2004, GDP in Argentina grew by 11.2% over its minimum level reached in the first quarter of 2002, although it is still below the highest figures recorded by the late 1990s. In Bolivia, GDP grew by 2.5% over 2003, mainly due to gas and soybean exports. In Brazil, the level of economic activity started recovering in 2004 (with a 2.7% growth), after having decreased in 2003 and having had a limited growth over the previous years. In Paraguay, the exceptional expansion of the agricultural sector –and especially of agricultural exports– led to a 2.6% GDP growth over 2003. Uruguay also followed the same trend of growth, led by the agricultural sector and owing to the considerable increase in agricultural activity linked to the production of cereals and oilseeds (CEPAL, 2004 b).

Table 2.11 shows the structure of domestic economies in 2002. A detail of the growth of the different production and consumption areas in the domestic economies over 2003 is presented in Table 2.12.

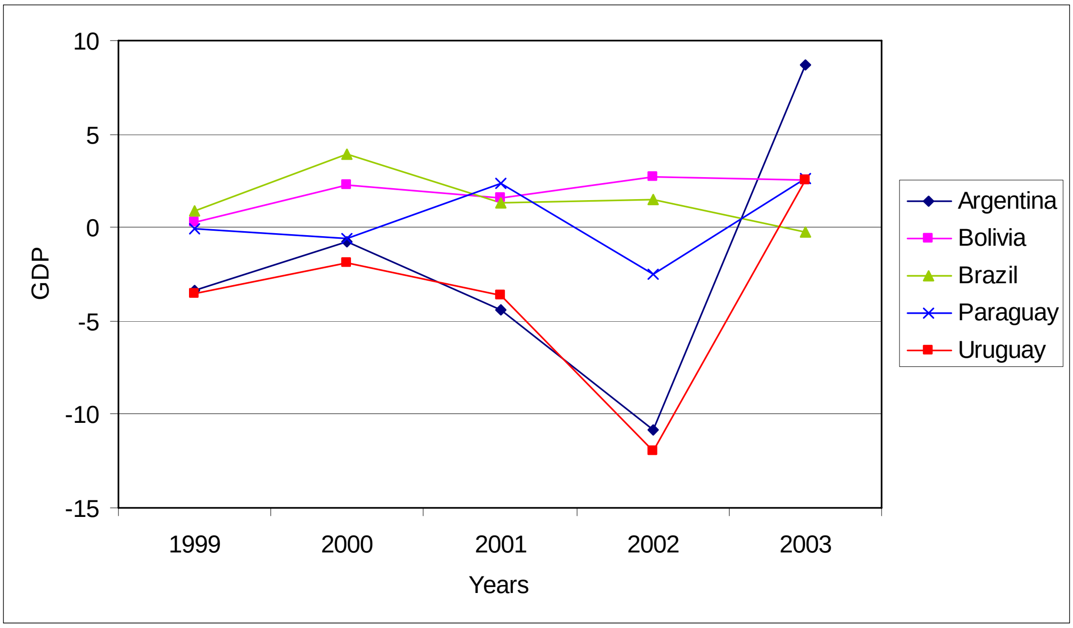
Table 2.11 shows the weight of the tertiary (services) sector in the structure of GDP, possibly associated with the predominance of urban areas and the growth in financial services over recent years.

Table 2.10. La Plata River Basin. GDP and GDP per capita, by country

Countries	GDP		GDP per Capita	
	USD Billions	PPP* USD Billions	USD	PPP* USD
Argentina	102.0	412.7	2,797	10,880
Bolivia	12.1	26.3	3,609	2,460
Brazil	452.4	1355.0	2,593	7,770
Paraguay	5.5	25.4	1,000	4,610
Uruguay	7.8	21.6	896	7,830

Note: * PPP Purchasing Power Parity
Source: UNDP, 2004.

Figure 2.4. La Plata River Basin. Evolution of average annual rates of gross domestic product (GDP) at constant market prices, by country (1999-2003)



Source: CEPAL, 2004 a & 2004 b

There is a general growth in all the sectors of economic activity. The greatest improvement in Argentina was observed in construction and industry sectors. The growth of industrial activity was led by textile and metal-mechanic industries. There was a similar growth recorded for construction materials. The agricultural and livestock activity expanded due to the increase in the grain crop, especially soybean (CEPAL, 2004 a).

Table 2.11. La Plata River Basin. Structure of the economy (% of GDP in 2002), by country

Sectors	Countries				
	Argentina	Bolivia	Brazil	Paraguay	Uruguay
Agriculture	10.7	14.6	5.8	22.0	9.4
Industry **- Manufacturing**	32.0 21.3	33.3 15.0	20.6 12.4	28.4 14.5	27.0 17.6
Services	57.3	52.1	73.5	49.6	63.5
Private Consumption	60.9	74.8	58.1	83.9	72.7
General Government Consumption	12.2	15.4	20.1	7.8	12.9
Imports of Goods and Services	12.8	26.9	13.4	41.9	19.6

Source: The World Bank Group, 2004

Table 2.12. La Plata River Basin. Economic annual growth by sector and country (2003)

Sectors	Annual growth (%)				
	Argentina	Bolivia	Brazil	Paraguay	Uruguay
Agriculture, Livestock, Hunting, Fishing, and Forestry	6.7	6.0	5.0	9.5	14.4
Mining	3.7	6.4	2.8	6.2	-7.2
Manufacturing Industry	15.8	2.7	0.7	-1.0	4.6
Electricity, Gas and Water	6.9	0.9	1.9	-2.6	-7.6
Construction	34.3	-18.4	-8.6	5.7	-7.1
Commerce, Restaurants and Hotels	11.1	2.0	-2.6	1.2	-0.9
Transport	8.3	3.7	-0.3	-2.0	2.8
Financial, Insurance, Real Estate Companies	-1.1	-1.3	0.6	---	-5.4
Communal, Social and Personal Services	2.8	4.5	-0.5	-2.0	0.7
Private Consumption	8.1	0.9	-3.3	4.8	-1.0
General Government Consumption	1.5	3.2	0.6	-7.2	-2.0
Imports of Goods and Services	37.6	-2.7	-1.8	15.4	1.6
Exports of Goods and Services	6.4	10.1	15.5	13.2	4.1

Source: CEPAL, 2004 b

In Brazil agriculture and livestock sector had the greatest growth, whereas the manufacturing industry had low dynamism, and construction showed a marked reduction. Such trends reverted in 2004, when the industrial growth rate accelerated owing to the recovery of domestic consumption and a growth in exports (CEPAL, 2004 b).

The growth of the primary sector in Paraguay was closely linked to a record harvest of soybean. Construction had a relative recovery in 2003, after a strong retraction in the previous two-year period (CEPAL, 2004 b).

Agriculture and livestock sector has also a strong growth in Uruguay. In fact, it was the largest growth among the riparian countries, and it was associated with the increase in cereal and oilseed production, and the recovery of the livestock activity. The decline in the construction and electricity sectors is related to the fall in domestic consumption, as well as the poor performance of public construction (CEPAL, 2004 b).

2.4.1.3. Cultural Background

The official religion in the riparian countries is the Catholic, which is practised by most of the population: Argentina (90%), Brazil (90%), Bolivia (88%), Paraguay (90%) and Uruguay (66%). All the national constitutions guarantee freedom of religion and, accordingly, there are adherents of other religions and cults practised by native peoples.

The official language is Spanish in the countries, except for Brazil, where the official language is Portuguese. Bolivia and Paraguay have also aboriginal tongues as official languages; they are Quechua, Aymara and Tupi-guaraní in Bolivia and Guaraní in Paraguay. In addition, a number of foreign languages are spoken (Chinese, German, Korean, Italian, etc.), preserved by the immigrants arrived to the countries in diverse periods.

White population prevails, although other ethnic groups are represented, such as black, yellow and aboriginal ones. Bolivia, for example, has a high percentage of indigenous population. In the provinces of the La Plata Basin live 509,205 indigenous, which represent around a 30% of the total population. The Quechuas predominate among indigenous, with a 94% of the native population (INE, 2001).

2.5. Education and Health in the La Plata Basin

2.5.1. Illiteracy Rate and Enrolment in Schools

Riparian countries of the La Plata Basin have a high level of school education, which is reflected in the low illiteracy rates mainly in Argentina, Paraguay and Uruguay (Table 2.13).

The same table shows that total illiteracy rates have been decreasing since the 1990s, being Bolivia and Brazil the countries where the decrease of this indicator was bigger. The improvement in the illiteracy rate in these two countries is most relevant since they have the worst values of this indicator.

Regarding gender, females have a higher illiteracy rate, mostly in Bolivia, where gender differences are important (17% in 1990 and 13% in 2001). In general, there is also an improvement in illiteracy rates by gender being more significant in the case of females.

Another indicator that describes education status in the La Plata Basin is the school enrolment rate in four educational levels: initial (pre-school), primary, secondary and tertiary, presented in Table 2.14.

Table 2.13. La Plata River Basin. Illiteracy rate by gender and country.

Countries	Illiteracy Rate (Population Aged 15 and Over)					
	Year 1990			Last Registered Data*		
	Total	Male	Female	Total	Male	Female
Argentina	4.3	4.1	4.4	2.5	2.1	2.1
Bolivia	21.9	13.2	30.2	13.3	6.9	19.4
Brazil	18.0	17.1	18.8	13.3	13.3	13.3
Paraguay	9.7	7.6	11.7	6.7	5.6	7.8
Uruguay	3.5	4.0	3.0	3.2	3.7	2.7

* Last registered data in Argentina and Bolivia, 2001; Brazil, 2000; Uruguay, 1996. Estimated data for Paraguay (CEPAL, 2004 a)
Sources: CEPAL 2004 a; INDEC, 2001; INE, 2001 a; IBGE, 2000; INE, 1996.

Table 2.14. La Plata River Basin. Enrolment in schools, by country.

Countries	Gross Enrolment in Schools (%) by Level			
	Initial	First	Second	Third
Argentina	64.4	93.1	95.5	36.6
Bolivia	5.4	61.3	18.5	12.1
Brazil	54.2	90.0	81.7	12.9
Paraguay	19.3	86.1	22.3	10.5
Uruguay	64.1	71.2	85.0	42.4

Sources: INDEC, 2001; INE, 2001 a; IBGE, 2000; DGEEC, 2002; INE, 2004

Argentina has the highest percentage of enrolled population, especially in secondary school (95%). Uruguay also has very good secondary and tertiary enrolment percentages, being the latter the best of the basin. Brazil has a high rate of enrolled population in primary school, as well as Bolivia and Paraguay. These last two countries have, on the other hand, the lowest enrolment rates in the basin, considering all the four education levels.

2.5.2. Life Expectancy and Mortality Rate

In general terms, population of the La Plata Basin has a life expectancy ranging between 60 and 76 years. There are significant differences from country to country, which shows different degrees of social development and living standards. Beyond these differences, the five riparian countries have improved life expectancy at birth, between 1995-2000 and 2000-2005 periods (see Table 2.15).

Gender distribution of life expectancy shows an usual characteristic of this indicator, such as females having a better life expectancy than males (Table 2.16). Improvements in the indicator have also been observed between the two periods under consideration.

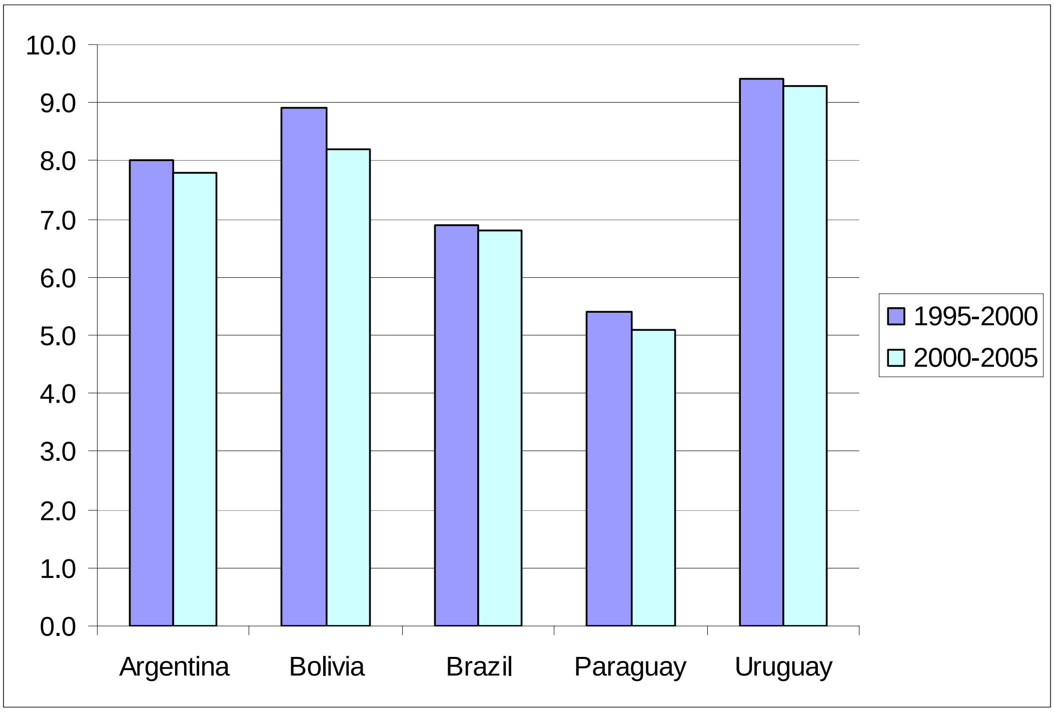
Table 2.15. La Plata River Basin. Life expectancy at birth by gender and country. Five-year periods (1995-2005)

Countries	1995-2000			2000-2005		
	Total	Males	Females	Total	Males	Females
Argentina	75.5	72.5	78.4	76.3	73.3	79.2
Bolivia	60.1	64.0	63.8	61.8	66.0	65.5
Brazil	67.9	64.1	71.9	69.3	65.5	73.3
Paraguay	69.7	67.5	72.0	70.8	68.6	73.1
Uruguay	74.1	70.5	78.0	75.2	71.6	78.9

Source: CEPAL, 2004 a

The health status in the basin can also be described through the general mortality rate (shown in Figure 2.5) and infant mortality rate[10] (shown in Table 2.16).

Figure 2.5. La Plata Basin. Mortality rate by five-year periods (1995-2005)



Source: CEPAL, 2004 a

General mortality rate shows little variation among the countries, with a maximum of 9.4 in Uruguay and a minimum of 5.4 in Paraguay during the 1995-2000 period. There is a slight improvement in the 2000-2005 period, with a maximum of 9.3 in Uruguay and a minimum of 5.1 in Paraguay. The indicator has also decreased in the rest of the countries.

[10] Infant mortality rate is an indicator which provides information on infant health during the first years of life and maternal health, as well as general health conditions of population.

Table 2.16. La Plata River Basin. Infant mortality rate by gender and country. Five -year periods (1995-2005)

Countries	1995-2000			2000-2005		
	Total	Males	Females	Total	Males	Females
Argentina	20.0	22.2	17.7	17.9	19.7	15.8
Bolivia	55.6	60.0	51.0	45.6	50.0	41.0
Brazil	38.1	44.0	32.0	33.6	39.0	28.0
Paraguay	37.0	41.9	31.8	34.0	38.7	29.0
Uruguay	13.1	15.5	10.5	12.0	14.1	9.8

Source: CEPAL, 2004 a

Infant mortality is very high in Bolivia, with a 55.1 rate in the 1995-2000 period. There is a decrease during the 2000-2005 period, but it is still a high mortality rate. Better situations can be observed in Paraguay and Brazil (with 37 and 38.1 mortality rates, respectively), whereas Uruguay and Argentina have the lowest values and, therefore, the best health conditions of the basin.

Infant mortality rate for males is the highest in the five countries. The scheme described for total infant mortality is repeated for both male and female rates. Again, the indicators (total, male, female) decreased in the 2000-2005 period in all the countries.

3. Water resources in the La Plata Basin

The description of surface waters in the La Plata Basin was made considering hydrographical as well as hydrological and water quality aspects for the La Plata River, its two major tributaries (Paraná and Uruguay rivers) and the major tributaries of the latter, both international (Paraguay, Iguazú, Pilcomayo, Bermejo and Negro) and national (Tietê and Salado del Norte).

3.1. Hydrography and hydrology

- La Plata River

The La Plata River, which covers an area of 35,000 km^2, originates at the confluence of the Uruguay River and the Paraná River. The river has a 40 km width at its source and it increases progressively as it flows southeast. Its bed is not very deep and has large banks of sand and silt, such as Playa Honda and Placer de las Palmas, which may be deemed as underwater extensions of the Paraná Delta (Mugetti, 2004).

The La Plata River may be divided into three sections: its upper zone extends between its source and the line uniting Colonia del Sacramento and Punta Lara; its middle zone extends up to the Montevideo-Punta Piedras line, and its lower zone extends up to the river's mouth at the Punta del Este-Punta Norte of San Antonio Cape line. Upper and middle zones form the "Inner La Plata River" and the lower zone is called "Outer La Plata River". The water in the Inner Zone is fresh and light brown, on account of the enormous amount of suspended silt supplied by the more remote tributaries, mainly the Bermejo River.

Differences may be observed along this river's banks. The Uruguayan bank is tall, irregular and rocky, with small islands, while the Argentinean one is low, has no islands and is subject to flooding, as is the case of the Samborombón Bay. The beaches on the Argentinean side are made of fine sand and silt, revealing tuff banks during the low tide (Mugetti, 2004).

The river's regime depends on oceanic and meteorological factors more than on the flow rate variations of its tributaries. In fact, even though the amount of water supplied by the high flows of the Paraná and Uruguay rivers is enormous, it has a minor influence on the La Plata River, whose funnel-like shape leads to remarkable water expansion, dispersing the high flows in its huge body, and thus preventing major changes in river level. However, ocean tides have a greater influence on the eastern portion, as do the winds, which are the main cause of major level changes (Mugetti, 2004).

Besides its two major tributaries, the La Plata River has other less significant tributaries: the Salado River, in the Buenos Aires Province (Argentina), and the Santa Lucía River (Uruguay). The former is about 475 km long, and its high flows are delayed respect to the rainy season as a result of the high infiltration of rainwater, which flows as groundwater until it rises to the surface again, originating these high flows (Mugetti, 2004). On the other hand, the Santa Lucía River supplies water to the entire Montevideo Department, where the national capital of Uruguay is located (Andrés *et al.,* 1999).

- Paraná River

The *Paraná River* originates at the confluence of the Paranaiba and Grande rivers. The river is later re-channelled through a massive basalt wash, where it carves its bed; this area comprises the entire headwaters and a part of the Upper Paraná. In the upper stretch, the Paraná River is a plateau watercourse, with rapids, falls, shoals, a tortuous bed and an irregular width –from 800 m at Angostura de Jupiá, it used to increase to as much as 4,000 m, as was the case of the Guayrá Falls, which mark the southernest limit of the Upper Paraná– (Bonetto & Hurtado, 1998).

Downstream from the Itaipú Dam and the mouth of the Iguazú River, the Paraná River changes its course to East-West, until it joins the Paraguay River. In this stretch the riverbed features change fast up to the Yacyretá-Apipé area, where the riverbed rises and basalt created low falls. The river expands greatly in an area with large islands, meanders and numerous sandbanks. Downstream from the Yacyretá dam, the river runs along a plain, where alluvial plains with a lengthened shape are observed; the river has sandy bed of varying width and depth (Bonetto & Hurtado, 1998).

After the confluence with the Paraguay River, the Middle Paraná stretch flows North-South along an extensive floodplain, which becomes slightly wider at the Santa Fe-Paraná segment. Downstream from the cities of Rosario and Diamante –where approximately the Lower Paraná begins– the position of the gorges is reversed, so that the lower and floodable bank is switched to the left margin, whereas the gorges take the right. This floodplain, with a decreased differentiation of lentic environments, flows southeast, and mingles with the Paraná Delta, which flows out frontally into the La Plata River (Bonetto & Hurtado, 1998). The last three stretches of the Paraná River (Middle and Lower Paraná and Delta) are entirely in Argentinean territory.

As part of its lengthy course, the Paraná River goes through regions of varying climates and receives tributaries from diverse geographic environments; therefore its regime is very peculiar. Its upper stretch has a tropical regime, characterised by summer high flows. The Iguazú River, a left-bank affluent, has a subtropical regime, with high flows occurring in autumn and spring. Conversely, although the Paraguay River Basin is located within the tropical area, it contributes water to the Paraná River in a delayed fashion as a result of the extensive Pantanal de Xarayes marshes. For this reason, the Paraná River flow rate is abundant throughout the entire year: it starts to rise in October, stops in January and February, drops slightly in March and April, picks up again in May and June, because of the Paraguay River's inflow, and finally descends again, so that it is at its lowest in September (Mugetti, 2004).

The major international Paraná River tributaries are the Iguazú and the Paraguay (with its Bermejo and Pilcomayo tributaries) rivers. The Tietê and Paranapanema rivers are important in Brazil, whereas the Salado del Norte is significant in Argentina. Some characteristics of these rivers are described below.

Iguazú River (Brazil/Argentina)

The Iguazú River originates at Serra do Mar –at 900 above sea level (m.a.s.l.)– and near Curitiba City (Brazil). At this point, and with the input of several tributaries, the river flows East-West.

The riverbed has around 70 falls and rapids, including the Ñanducay Rapid –which is 40 m high– and the falls that bear the same name. The Iguazú River spans 1,205 km in the Brazilian territory until it reaches the mouth of the San Antonio River, where its international segment begins (Argentina-Brazil). Then the river changes its course to the South, and along this short stretch it exhibits a number of dried-up riverbeds distributed along a succession of inclined planes that proceed the breathtaking Iguazú falls, which form a 2,700 m-long arch. Of these, 2,100 m belong to Argentina, and 600 m belong to Brazil.

The waters of the numerous falls unite along a short stretch, giving rise to Lower Iguazú, which flows into the Upper Paraná at Puerto Iguazú. The total length of this river is 1,320 km, and its difference in altitude amounts to 800 m, which explains its irregularities and its rocky and torrential nature (Bonetto & Hurtado, 1998).

Paraguay River (Brazil/Paraguay/Argentina)

The Paraguay River is the main tributary of the Paraná River. It originates in the heart of the tropical rainforest, in the Chapada dos Parecis, located at the South of the Mato Grosso plateau. This river runs for as much as 2,621 km before joining the Paraná River, forming the two arms that enclose the Atajo or Cerrito Island.

After receiving numerous tributaries on both margins, the Paraguay River makes its way into the Pantanal de Xarayes, where water is retained during the summer high flows. When rainfall subsides in the basin, the river starts to rise: its waters remain high during the second half of autumn and the first weeks of winter, and its flow rate remains stable during the dry season (Mugetti, 2004; Dias Coelho, 2004).

The Lower Pilcomayo River flows into the Paraguay River at Clorinda City (Argentina), from where the latter serves as a geographic boundary between Argentina and Paraguay. Its bed is deep, well defined and full of islands with low shores covered by a compact forest (Mugetti, 2004).

The Paraguay River Basin can be divided into two areas: Planalto (or plateau area, 215,963 km²), with heights exceeding 200 m, and Pantanal (147,629 km²), which is less than 200 m high, has a low drainage capacity, and is subject to heavy flooding. Runoff takes place in the Planalto-Pantanal direction, where river speed is reduced by a change in the waterline slope. As the river becomes narrower, sediments start to deposit on its bed and produces silting-up, making it loose its erosive capacity, and leading to a reduced river section (Dias Coelho, 2004).

Its regime is specific and subject to tropical summer rainfall. However, the high flows in the river's lower stretch are delayed as a result of the horizontality of the basin and the broad lateral swamps that retain huge amounts of water. The high flows do not progress downstream until the marshes are full, which occurs several months after the onset of the rainy season. This happens as late as May and June, and is followed by a slow in-drought period with a lowest level in December (Mugetti, 2004).

The Pilcomayo and Bermejo Rivers are the main Paraguay River's international tributaries.

The *Pilcomayo River (Bolivia/Paraguay/Argentina)* is 1,100 km long and originates in the Eastern Andes of Bolivia. It receives one of its major tributaries, the Grande de San Juan

River, which flows from the Jujuy Puna[11]. At Villamontes City (Bolivia) the Pilcomayo River enters the Boreal Chaco plain and runs with a Northwest-Southeast course along a territory characterised by scarce rainfalls and a gentle slope. The soil of this area is made of either sandy matter, which facilitates water infiltration, or clay, where water stagnates and gives rise to marshes. Some of 100 km Southeast from Punto Horqueta in the Eastern portion of the so-called Patiño marsh, two other watercourses originates: these are the North and South arms, which unite at the Juntas de Fontana, giving rise to the lower Pilcomayo, which flows out into the Paraguay River in front of Asunción City (Paraguay). Its bed is gorge-like (Mugetti, 2004).

The *Bermejo River (Bolivia/Argentina)* also originates in Bolivia and is 1,060 km long. Its upper stretch receives several tributaries from the mountains of the Argentinean Northwest. When the river enters Argentina, it takes a Southeast direction, and serves as an international boundary for a short stretch; then, the river receives the Lipeo and Pescado rivers on its right bank, and the Grande de Tarija River on its left bank. Throughout its entire upper stretch –along the Sub-Andean System– rainfall is abundant and occurs predominantly in summer, which determines a significant flow rate. As it runs through the plains, the Bermejo River forms broad meanders, until it receives the San Francisco River on its right bank. Then, the Bermejo enters the Chaco plain –always flowing southeast– and runs parallel to the Pilcomayo River. The river becomes as wide as 5 km, with several islands covered by dense forest, and it carries large amounts of red silt. Its course becomes very winding, with low banks covered by gallery forests; then it divides into several arms over clay soils that have given rise to the Quirquincho Marshes, East of which the streams are reunited into two arms, the Teuco River in the North, and the ancient stream of the Bermejo River in the South, which nowadays is almost always dry. Both arms reunite again some 400 km later at Confluencia, almost 440 km away from the mouth of the Paraguay River, giving rise to the lower Bermejo, with a gorge-like and well defined bed (Mugetti, 2004).

Other significant Paraná River tributaries are the Tietê and Paranapanema Rivers (Brazil) and the Salado del Norte (Argentina).

Tietê River

The Tietê River is the most important watercourse of São Paulo State, which crosses its capital city, São Paulo. The river originates at Serra do Mar, 1,120 m.a.s.l. Although its headwater zone is 22 km away from the Atlantic Ocean, it flows for more than 3,700 km before reaches the La Plata River through the Paraná River. In its headwaters, its waters are deviated into the sea through reservoir works, and are used for power generation at the Cubatão plants (Ministério dos Transportes, 2002 b).

The Tietê River's mouth is located at Alto do Paraná, close to the Urubupungá Falls –currently flooded by the Jupiá reservoir–, which serves as a reservoir for the Tietê River final stretches. The total length of the river is 1,150 km, and the difference in altitude between its headwaters and its mouth does not exceed 860 m, with a mean global slope of 74 cm/km. The different levels of its bed have been utilised for building dams for power generation (Ministério dos Transportes, 2002 b).

[11] The "Puna" or "Altiplano" is a 3,000 m high plain, located in the Central Andes ranges. It comprises the north of Chile, the western area of Bolivia, the centre and south of Perú and the northwest of Argentina.

The slope of the Tietê's riverbed is unstable, as is the land which it crosses along. At Serra do Mar the river's slope is marked, but it gradually diminishes as the river approaches the São Paulo plateau. At the river's stretch where waterfalls are located –between the São Paulo Municipality and the Itu Falls– its slope rises to over 200 cm/km. From there onwards, its mean slope drops to 30 cm/km (Ministério dos Transportes, 2002 b).

Paranapanema River

The Paranapanema River has a total length of 929 km, and it generally flows East-West. The headwaters are located in the Agudos Grandes Mountains, at Southeast of São Paulo State, at 900 m.a.s.l. From the Itararé River it forms the boundary between the States of Paraná and São Paulo. The total mean slope of the Paranapanema River is 61 cm/km (Ministério dos Transportes, 2002 a).

This river is divided into three main portions: the lower Paranapanema, with sand banks and islands; the middle Paranapanema, which boasts several dams; and the higher Paranapanema, where the mean slope is steepest. The large water amounts kept in the river's headwater dams have a considerable influence on the river's regime (Ministério dos Transportes, 2002 a).

Salado del Norte River

The Salado del Norte River is 1,150 km long, and its basin originates on the Eastern border of the Puna. When the river enters the Chaco plain, forms a broad bed that it occupies only partially, forming several arms. In the Province of Santiago del Estero, it forms wide marshlands or areas temporarily flooded during the summer major high waters. The river's flow rate is considerably impoverished downstream the Añatuya marshlands, where its bed remains dry almost all year round. When the river enters the Province of Santa Fe, it flows into a progressively rainier area, where the discharge increases again. Finally, it flows out into the Paraná River at the Southeast of Santa Fe City, in a flooding area where lagoons can be observed (Mugetti, 2004).

- <u>Uruguay River</u>

The *Uruguay River* originates at the confluence of the Canoas and Pelotas Rivers, whose headwaters are located on the western hillsides of Serra Geral, in the states of Santa Catarina and Rio Grande do Sul (Brazil). Its upper stretch, -with an East-West direction-, flows through the rocky formations of Brazil's Southern plateau, creating a terraced landscape with striking topographic differences, and receives numerous tributaries of moderate sizes but extremely tortuous characteristics. Then, and after reaching the international Argentinean-Brazilian boundary, the river bends Southwest and after passing the cities of Monte Caseros (Argentina) and Bella Unión (Uruguay), it takes a southbound course and flows into the La Plata River together with its Paraná counterpart.

The outstanding tortuousness and irregularity of this river from its headwaters to Santo Tomé City (Argentina) are two of its more steady characteristics. As it flows, this watercourse gradually increases in width, from 1,200 m at Paso de los Libres City (Argentina) to 1,900 at Salto Grande (Argentina-Uruguay). From there on, and coincidentally with the abrupt flatness of its bed in the lower and middle stretches, it acquires a width of 2,000 m at Puerto Colón (Argentina), 3,000 m at Concordia City (Argentina), and 7,500 m at the mouth of the

Gualeguaychú River, only to become narrower again –with a width of 4,000 m– at Nueva Palmira City (Uruguay) (Bonetto & Hurtado, 1998).

The Uruguay River's regime is subtropical. Its flow rate mainly depends on rainfall in its upper stretch, which is constant but becomes more accentuated in autumn and spring. That is why there are two high flows separated by a short-lasting low flow in August, and a highest low flow in summer (Mugetti, 2004). The heaviest rainfall takes place between April and mid-August, after which it declines, peaking again in October and declining abruptly until December, when the cycle restarts. Rains are less intense downstream, and the river's flow is hampered by low gradient and by the influence of tides and "*sudestadas*" (rainy wind storms from the Southeast) (Bonetto & Hurtado, 1998).

The main tributaries of the Uruguay River are the Negro and the Cuareim/Quaraí Rivers, both shared between Brazil and Uruguay.

The *Cuareim* or *Quaraí* River's Basin has a drainage area of around 14,800 km^2, 45% of which lies on Brazilian territory, with the remaining 55% in the Northwest bounds of Uruguay. The difference in altitude between its headwaters and its mouth is 326 m, and its average slope is 0.93m/km, with the steepest slopes located in the first fourth portion of its length. Most of the tributaries in the upper basin have a torrential regime and run through rocky areas. Runoff tends to occur after the rainfall season in all Cuareim tributaries; then it decreases sharply because the basin does not have significant storage capabilities. This determines a sharp pattern of high and low flows, with the river restoring its average flow rate –which tends to be small– in just a few days (CRC, 2004).

The *Negro River* originates in Brazil, runs around 750 km to the Southeast and flows into the Uruguay River. The Negro River Basin has a drainage area of 69,175 km^2, 95% of which belongs to Uruguay (von Cappeln, 2002).

3.1.1. Spatial variance of water availability

3.1.1.1. Surface water

Tables 3.1 to 3.3 show a summary of the La Plata Basin's water availability based on the flow rates in the three major sub-basins: Paraná, Paraguay and Uruguay. According to the data, a similar trend has been observed in the Paraná and Uruguay rivers, whereas the Paraguay River has a lower specific flow rate as a result of reduced rainfall and drainage.

The specific flow rate has a tendency to diminish as the basin's area increases, as a result of water loss through evapotranspiration and alterations in precipitation. In the Upper Paraná and Upper Uruguay rivers, most specific flow rates are between 10 to 22 l/s/km^2, which represent a runoff ratio of 30 to 40%. On the other hand, the specific flow rates of the Lower Paraná and the Paraguay rivers drop to values below 10 l/s/km^2, as a result of the influence of large flood areas. This becomes more evident if an analysis is made of the values pertaining to the Eastern and Western portions of the sub-basins of the Paraguay River in Paraguay.

Table 3.1. Paraguay River Basin and its sub-basins. Water availability

River	Basin area km^2	River flow m^3/s	Specific discharge (l/s/ km^2)
Pilcomayo	96,000	203	2.1
Bermejo	65,736	408	6.2
Tarija	10,460	129	12.3
San Francisco	25,800	104	4.0
Eastern			
Apa	15,560	202	13.0
Aquidabán	11,532	172	14.9
Ypané	9,935	165	16.6
Jejuí Guazú	20,073	325	16.2
Manduvirá	9,401	136	14.5
Piribebuy	1,405	17	12.1
Salado	1,066	13	12.2
Asunción	2,557	26	10.2
Alberdi	5,19	6	11.6
Tebicuary	31,317	506	16.2
Riacho La Paz	3,884	36	9.3
Arroyo Saladillo	914	10	10.9
Riacho Cuarepotí	5,682	57	10.0
Pilar	3,003	35	11.7
Western			
Fortín Galpón	3,180	3	0.9
Timane	56,350	134	2.4
Riacho Yacaré	24,460	143	5.8
Melo	14,960	78	5.2
Riach. Yacaré Norte	22,010	168	7.6
Riacho San Carlos	18,200	147	8.1
Verde	24,380	255	10.5
Siete Puntas	6,570	52	7.9
Montelindo	5,140	27	5.3
Riacho Negro	6,579	52	7.9
Acaray Guazú	6,750	51	7.6
Confuso	6,066	39	6.4
Pilcomayo	37,029	159	4.3

Source: Tucci (2004)

Table 3.2. Uruguay River Basin and its sub-basins. Water availability

River	Basin area km^2	River flow m^3/s	Specific discharge (l/s/ km^2)
Marcelino Ramos – Uruguay River	41,267	863.6	20.9
Itá – Uruguay River	43,901	968	22.0
Passo Caxambu - Uruguay River	52,671	1124	21.3
Iraí - Uruguay River	62,199	1295	20.8
Manuel Viana - Ibicuí River	28,820	541	18.8

River	Basin area km^2	River flow m^3/s	Specific discharge (l/s/ km^2)
Mariano Pinto – Ibicuí River	35,935	806	20.8
P^o Aguiar –Negro River	8,148	124.5	15.3
R.Tacuarembó	11,800	180.5	15.3
Uruguaiana – Uruguay River	189,300	4368	23.1
Source: Tucci (2004)			

Table 3.3. Paraná River Basin and its sub-basins. Water availability

River	Basin area km^2	River flow m^3/s	Specific discharge (l/s/ km^2)
Paraná	2,346,000	15240.0	6.5
Iguazú	67,291	1851.0	27.5
Corrientes	22,100	329.0	14.9
Upper Paraná (Py and Br)	20,472	420.0	20.5
Acaray	9,802	180.0	18.4
Monday	6,557	125.0	19.0

Source: Tucci (2004).

- Main rivers and tributaries

- La Plata River

The La Plata River receives an average annual flow rate of 18,000 m^3/s from the Paraguay-Paraná rivers and 5,000 m^3/s from the Uruguay River; the contribution from its minor tributaries is scarce (Bonetto & Hurtado, 1998).

- Paraná River

The Brazilian sector of the Paraná Basin has a mean long-term flow rate of 10,371 m^3/s (6.5% of the total Brazilian territory) and its specific contribution is 11.8 l/s/km^2, with lower values in the hydrographical units of the Paraná (5.6 l/s/km^2), Tietê (8.6 l/s/km^2) and Paranapanema (10.6 l/s/km^2) rivers, and higher values in the region of the Iguazú River (22.2 l/s/km^2) and the Grande River (17.0 l/s/km^2).

The major specific contributions are observed at the headwaters, albeit with a lower seasonal regularity. Interannual variability has been observed, with increases in the mean flow rate of the Paraná River. This may be explained by two processes: an increase in rainfall between 1970 and 2000, in contrast with the previous period (1930-1970); and deforestation coupled with a rise in annual crop farming after 1970, when coffee was replaced by soybean, wheat and maize in the Paraná State (Brazil). The main water availability problems are in the São Paulo Metropolitan Area, where water is insufficient for catering to supply demands (Días Coelho, 2004).

Tributaries of the Paraná River

Iguazú River: the river has two annual pulses and high flows –the highest occurring in June, with a more reduced but long-lasting counterpart in October–, which bear the characteristics of the Upper Iguazú stretch, whereas the shorter portion that constitutes the Lower Iguazú is more similar to the Paraná River. Another characteristic of the Iguazú River is the highly irregular flow rates, which fluctuate between 25,000 m^3/s and a minimum barely higher than 200 m^3/s, with a mean of 1,500 m^3/s (Bonetto & Hurtado, 1998).

Paraguay River: the mean flow rate of the Paraguay River is 3,800 m^3/s. Water loss occurs on account of the high potential evapotranspiration, chiefly concentrated in the Pantanal, which leads to a specific mean flow rate of 5 l/s/km^2. In the plateau area (locally know as Planalto), mean long-term water availability is about of 20 l/s/km^2, meanwhile the highest values are observed in the upper basin, with the lowest values amounting to about 15 l/s/km^2. The rain season lasts from October to March, with the low waters occurring in the remaining months.

The low waters patterns were at their most critical stage between 1960 and 1973. After the 1970s, flow rates and flood areas considerably exceeded those observed during the previous period, surpassing those occurring before the 1960s by 25 %. The mean flow rate at Porto Esperança (Brazil) was 2,165 m^3/s between 1970 and 1981, and the sum of all Planalto-bound Pantanal contributions amounted to 2,058 m^3/s. Of these values, a mean flow rate of 107 m^3/s may be estimated in the Pantanal, which is equivalent to a specific flow rate of 0.9 l/s/km^2 and a runoff ratio of 5%. These values may be explained by the reduction in runoff resulting from sedimentation, silting-up of the riverbed and loss of river's erosive capacity (Dias Coelho, 2004).

Pilcomayo River: Its flow rate is highly variable, with peak high flows of 3,000 m^3/s or more, and low flows of up to 3 m^3/s, as a consequence of the rainfall regime, which involves intensive rainfall during summer (December through March) and a total lack of regulation in the upper basin. Overflows occur during the high flow season (January through March), as the cross-sectional capacity of the river is exceeded. Likewise, during the entire hydrological year, the water arrives at a obstruction site in the riverbed and overflows both banks in amounts that depend on the topographic conditions of the area, or man's interventions in it. This volume of water gives rise to wide wetlands, which play a key role in the development of fish fauna (Comisión Trinacional para el Desarrollo de la Cuenca del Río Pilcomayo, 2002).

- <u>Uruguay River</u>

The mean annual flow rate of the Uruguay River Basin in Brazil is 4,117 m^3/s, which accounts for 2.6% of the country's freshwater availability. The mean specific discharge in the region is high –23.6 l/s/km^2– with values oscillating between 19.5 l/s/km^2 in the Negro River sub-basin, and 31.5 l/s/km^2 in the Peperi-Guaçu/Antas sub-basin (Dias Coelho, 2004).

Tributaries of the Uruguay River

Cuareim/Quarai River: The highest flow rate ever recorded occurred in April 1991: the gauge level reached 13.35 m at the Artigas City (Uruguay), and the total flow rate was 4,653 m^3/s. The maximum level of this river was observed on the same day, and it amounted to 13.75 m at the local gauge. On the other hand, the low waters gauging in the Cuareim River does not provide trustworthy information on its specific natural minimum flow rates, because they are biased by water extractions for rice paddy irrigation. As a result, it is extremely difficult to quantify this river's low stages properly (CRC, 2004).

As a synthesis, Table 3.4 shows the main characteristics of the major rivers in the La Plata Basin.

Table 3.4. La Plata River Basin. Main characteristics of the rivers

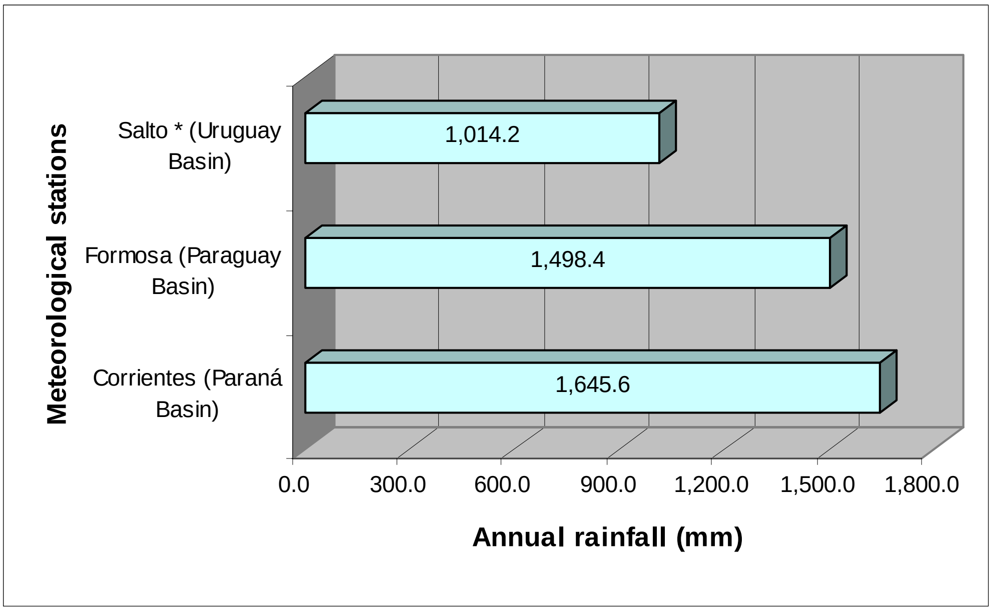
River	Basin area (km^2)	Length (km)	Average flow (m^3/s)
Paraná	1,600,000	2,570	17,140
Uruguay	440,000	1,850	4,500
Iguazú	61,000	1,320	1,540
Paraguay	1,095,000	2,415	3,810
Bermejo	120,000	1,780	550
Pilcomayo	272,000	1,125	195
La Plata	3,100,000	270	23,000-28,000

Source: UNEP, 2004

- *Annual precipitation and runoff*

Low-layer atmospheric circulation in the basin is characterised by Northern winds. In the South of the basin, winds blow predominantly from the West. During the warmer half of the year –October through April–, mesoscale convective systems (MCS) are frequent in the La Plata Basin, and are responsible for much of the total rainfall and most local floods (Barros *et al.*, 2004). Figure 3.1 shows mean precipitation records in three meteorological stations located in the Middle Paraná and Uruguay basins (Argentina and Uruguay).

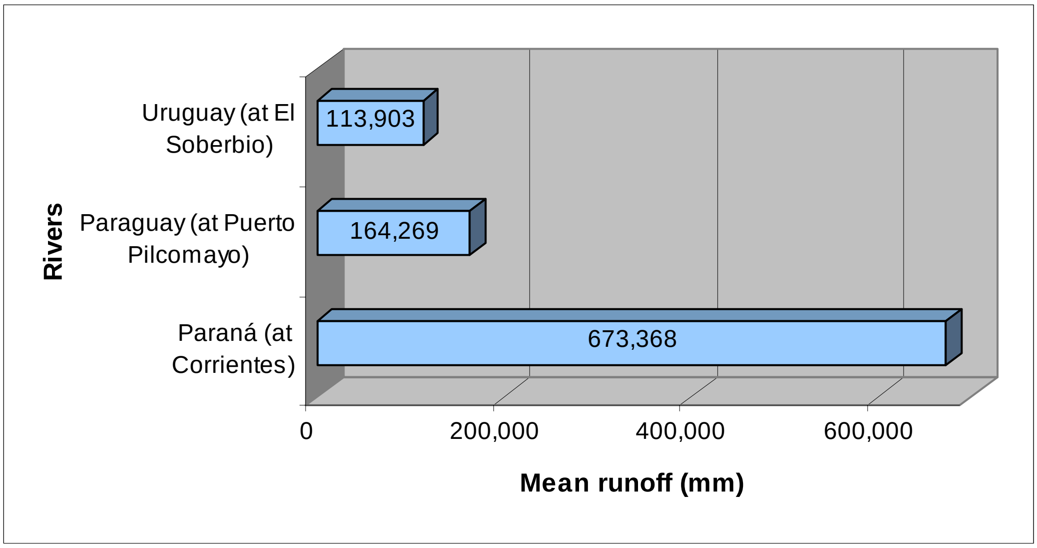
Figure 3.1. La Plata River Basin. Annual rainfall in selected meteorological stations (1980-1990)



Note: * Average between 1961-1990.
Source: SMN, 1992; DNM, 1992

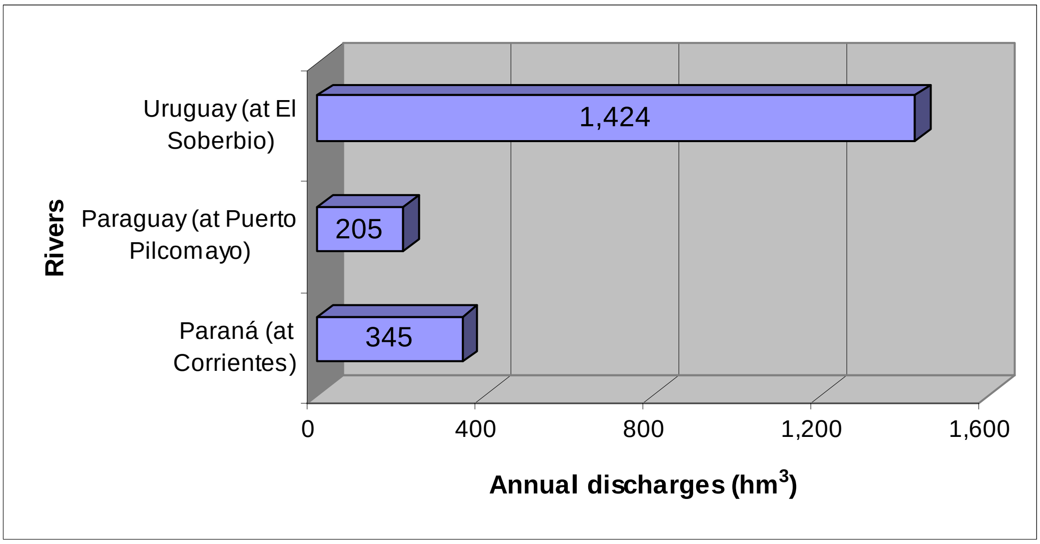
Figures 3.2 and 3.3 show mean runoff and annual volume in three gauging stations located at the Argentinean sector of the Paraná, Paraguay and Uruguay rivers. The stations of the Paraná and Paraguay Rivers are located downstream of the mouths of their most important tributaries.

Figure 3.2. La Plata River Basin. Mean annual runoff of the main rivers (1980-1990)



Source: SSRH, 2000

Figure 3.3. La Plata River Basin. Mean annual discharges of the main rivers (1980-1990)



Source: SSRH, 2000

- Lakes and reservoirs

The construction of *Itaipú Dam* has created an elongated and wide lake with complex and irregular morphometric characteristics, which forms the end of all Brazilian and Brazilian-

Paraguayan dams. The Itaipú Lake sets in the Guarapuava Plateau, which stands out for its geologic uniformity, with large basalt lava washes and hydromorphic, and organic red and yellow podzolic soils (Bonetto & Hurtado, 1998). The lake has an area of 1,350 km^2 at normal level, amounting to 1,460 km^2 during the maximum operation level. Most of the lake –57% of its area– lies on Brazilian territory, whereas the remaining 43% is located in Paraguay. It has 66 small islands and its formation has helped to expand fishing in the area (Itaipú Binacional, 2005).

The *Yacyretá Dam* is located in the stretch of the Paraná River that flows East-West, at the Southeast of Paraguay and Northeast of Argentina. Its drainage basin amounts to 970,000 km^2. The dam's lake has an area of 1,600 km^2 (Entidad Binacional Yacyretá, 2005). Though it is mainly used for hydropower, the reservoir has also been constructed to improve navigation along the Upper Paraná and to promote economic development in the Northeast of Argentina and South of Paraguay. On the Paraguayan side, Yacyretá has enabled irrigation and drainage works across an area of 1,400 km^2, while on the Argentinean side, it delivers water to an area of some 67 km^2, which is suitable for farming in general, and rice farming in particular (SSRH, 2001).

The *Salto Grande Dam* lies on the Uruguay River and has been built upstream from the cities of Concordia (Argentina) and Salto (Uruguay). Construction began in 1973 and the power generation facilities were commissioned in 1982. Though mainly designed for power generation, it is also used for water supply and navigation. The reservoir delivers electricity to Argentina and Uruguay (SSRH, 2001). It is a huge lake that spans an area of 75,000 ha, and is ideal for water sports (windsurf, yachting, rowing, etc.). Its irregular shores have given shape to beautiful landscapes; beaches and camping areas are abundant, and quality services are available for visitors (CTMSG, 2004).

The *Bonete, Baigorria* and *Palmar* reservoirs lie on the Negro River (Uruguay), and take up 1,070 km^2, 100 km^2 and 320 km^2 respectively. They were initially built for hydropower generation (amounting to 600 Mw in total), and are currently used for several purposes. Water quality has been impaired by eutrophication –this being the case of Bonete–, algae blooms, high aggressiveness of water and colonisation by exotic molluscs (Gorja *et al.*, 2002).

3.1.1.2. Groundwater aquifers

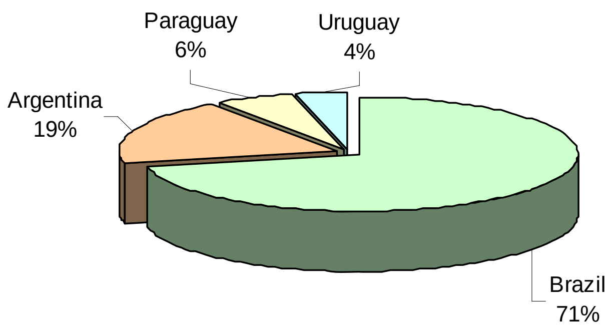
The main aquifer of the La Plata Basin is the *Sistema Acuífero Guaraní* (Guaraní Aquifer System), which is shared by Argentina, Brazil, Paraguay and Uruguay. It is one of the largest groundwater reservoirs in the world, taking up an area of around 1,190,000 km^2, which are distributed as Figure 3.4 shows.

Water from the aquifer may be extracted at variable depths –between 50 and 1,500 m. In Argentina, it lies at more than 900 m depth. As a result of its considerable depth, its temperature ranges between 33ºC and 65ºC. In general, the aquifer has surge pressure, so that when the ground is drilled up to its depth, water rises naturally and often emerges above ground level (Santa Cruz, 2004).

Although the Guaraní Aquífer has a huge water storage (37,000 km^3), the volume that can actually be exploited –estimated as regulation or renewable reserves–, does not exceed 40 to

80 km^3/year. This volume is comparable to one-third of the total runoff of the Uruguay River, and is equal to four times the total annual water demand of Argentina (Santa Cruz, 2004).

Figure 3.4. Area of Guaraní Aquifer System in countries of the La Plata Basin



Source: Santa Cruz, 2004

Brazil is the country that exploits the aquifer more intensively, delivering water either totally or partially to 300-500 cities. Uruguay has 135 public water wells, some of which are used for thermal exploitation. Paraguay has about 200 wells, mainly devoted to human uses. Finally, Argentina has five thermal freshwater wells and one saltwater well in operation at the beginning of 2000s (Santa Cruz, 2004).

The groundwater of the Guaraní System originated in ancient geologic formations, dated from 200 to 132 million years. After a series of geologic events, which enabled over 1,000-meter-thick rocks to deposit as sediment throughout the area, geologic structures and faults started to originate and reactivate, altering the established stratigraphic order as well as the original orientations and heights. This was added to erosive processes acting during several million years. In this virtually final geologic scenario, the more permeable rocks started to fill with water through infiltration processes; water started to circulate slowly from the upwelling –or recharge areas–, to the subsidence and confinement –transit and discharge– areas. The large-scale onset of this process goes as far back as 20,000 years ago (Santa Cruz, 2004).

Other aquifers currently exploited in Argentina, Brazil, Paraguay and Uruguay are briefly described below.

- Argentina (source: Mugetti, 2004)

a) *Recent Pliocene silts*: They can be found in some areas of the provinces of Formosa, Chaco, Salta, Santiago del Estero and Santa Fe. Free or semi-free layers are exploited, being water quality conditioned by several factors. Average water depth ranges between 5 m in the East and 35 m in the West. Laterally discontinuous aquifers are developed at depths of 100 to 200 m in the medium-high permeability strip, with good chemical and hydraulic conditions.

b) *Puelches and Ituzaingó Formations*: This sub-region is divided by the Paraná River, and stretches from the Northwest of the Province of Formosa to the Samborombón Bay (Province of Buenos Aires). The Ituzaingó formation environments have water of good quality and mean specific discharge between 4 and 5 m^3/h/m, amounting to 10 m^3/h/m in some locations. Specific discharge in Puelches formation oscillates between 4 and 20 m^3/h/m.

c) *Santiago Temple Formation*: this aquifer ranges between 100 and 400 m in thickness, and stretches throughout the foothills of Sierra Chica, in the Province of Córdoba. Water level is stable at 10 m deep, but it rises abruptly to a maximum of 100 m as the formation draws closer to the hill. The specific discharges of the confined layers are high, exceeding 10 m^3/h/m.

d) *Pampeano Aquifer*: this regional aquifer is exploited in the provinces of Buenos Aires, La Pampa, Córdoba and Santa Fe. The slight granulometric variations have given rise to lenses of moderate permeability, with production levels of good quality and low yields.

e) *Médano Invasor Aquifer*: this aquifer is located in the South of the provinces of San Luis and Córdoba, the North of La Pampa and the West-Northwest of Buenos Aires. It stands out for sediments of medium-high permeability, and for discontinuous underground aquifers characterised by good chemical quality and low yields.

f) *Phreatic Aquifer*: the characteristics of the phreatic aquifer vary depending on the geologic composition of the various areas. Flow rates of 5 m^3/h can be obtained in the dunes, with total saline content amounting to 0.4 g/l. Towards the South, the aquifer is lodged within the friable sandstones of the Río Negro Formation, with a total saline content of 2 g/l.

g) *Confined Aquifer*: in the Pliocene layers, which are made of 120-meter-thick silt-clay sandstones, the number of aquifers levels decreases towards the East and South. In general, water has a high saline content, and flow rates are scarce. The water layers of the Higher Miocene are chiefly made of clay of oceanic origin. In general, aquifer layers are thin, with meagre flow rates and abundant saline content.

h) *Misiones Plateau Region*: the hydrogeologic environment of the Province of Misiones, the East of Corrientes and the Northeast of Entre Ríos has secondary porosity by fissures. Perforations, which amount to 120 m, drilled through basalt and sandstone layers, result in erratic exploitation flow rates (with ranges between 0 and 100 m^3/h).

- Brazil (source: Dias Coelho, 2004)

a) *Bauru porous aquifer system*: the system has originated on a bed of sediment and basalt lava; it has a mean thickness of 200 m and lines the Serra Geral hill. It takes up the entire centre of the Paraná Basin and has an estimated area of 315,000 km^2.

b) *Serra Geral fractured aquifer system*: with a mean thickness of 150 m, this system takes up the entire southern portion of the Paraná Basin. The system was originated in igneous and metamorphic rocks.

c) *Cuiabá fractured aquifer system*: this aquifer, located at Northeast of the Paraguay River Basin, is used to supply water to the Cuiabá City and the industries in the region.

Other aquifers: there are alluvial aquifers in the Uruguay Basin that are restricted to the stretches of some rivers and have significant flow rate variability. The porous aquifers of Furnas and Ponta Grossa, which lie in the Paraguay River Basin, can be found in the East, in the Planalto (plateau) region.

- Paraguay

In Paraguay, there are three relevant aquifers within the La Plata Basin used for groundwater extraction. The *Patiño aquifer* lies in the centre of the country; the *Misiones aquifer* is part of the greater Guaraní Aquifer System; and the *Yrendá aquifer* (known as Toba Aquifer in Argentina and Tarijeño Aquifer in Bolivia) is located in Central Chaco, and is shared by Argentina, Bolivia and Paraguay (Monte Domecq, 2004).

- Uruguay (source: Genta *et al.*, 2004):

a) *Raigón Aquifer*: this aquifer is located in the South, and has an area of 1,800 km^2. Its flow rates can be as high as 150 m^3/h. Water is extracted for farming, irrigation, industry and human consumption.

b) *Arapey Aquifer*: this aquifer is located in the Northwest, and its flow rates range between 5 and 15 m^3/h. Water is extracted for irrigation.

c) *Salto Aquifer*: this aquifer is located in the Northwest, and its flow rates range between 0 and 15 m^3/h. Water is extracted for irrigation.

d) *Mercedes Aquifer*: this aquifer is located in the West, has an area of 20,000 km^2 and a maximum flow rate of 100 m^3/h. The water extracted is delivered to farms and human settlements.

e) *Minor coastal aquifers*: they are located in the centre of the country, South from the Negro River. Their yield is low –lower than 100 m^3/h– and the water extracted is used for human and animal consumption.

- *Groundwater prospects*

Groundwater resources are increasing their importance as a supply of diverse productive activities. As the share of groundwater in the total water supply is on the rise, the reserve of the resource grows not only in the La Plata Basin, but also in the whole Latin America, due to the discovery of new sources (Hernández, 2005).

The expansion in the use of groundwater brings along an increment in conflicts, not only due to the expansion process itself, but also between different types of uses (irrigation, drinking water supply, industries). For example, lack of planning in the distribution of the exploitation wells produces a physical deterioration of vast depressed areas; this situation would turn even complex in case of saline intrusion. In other cases, substitution of the groundwater source by a surface one generates a recovery of the piezometric levels that might affect diverse types of infrastructure (Hernández, 2005).

Besides all these problems, there are additional complications related to socioeconomic and political situations in each country. Lack of governmental control through regulation entities and efficient public policies, privatisation and/or concession processes of water services in the countries, lack of research and technical knowledge and the tendency of consider economic factors rather than social ones, are some of the worst problems related to the use of groundwater in these countries (Hernández, 2005).

Regarding to future prospects, there are no signs of changes towards a sustainable use of groundwater, tending to solve the most urgent problems. Except for the case of Brazil, where the *Agência Nacional de Aguas,* ANA (National Water Agency) has been created, the other countries have not improved much their situations or they even have gone back, as Argentina, where 20 years ago there used to be major evaluation projects (Hernández, 2005).

In spite of this situation, there is an encouraging example in the basin. The *Project for Environmental Protection of the Guaraní Aquifer System*, approved by the Global Environmental Facility in 2001 is being carried out by the countries that share the groundwater system (Hernández, 2005). This project has the environmental protection as its main goal and it foresees scientific and technical actions in diverse issues of Geology, Hydrogeology, Geophysics, Geochemistry, Information Systems, Environment, Geothermic Engineering, Sociology, Education, Legislation and others (Santa Cruz, 2004).

3.1.2. Spatial variance of water quality (both surface and groundwater)

- <u>La Plata River</u>

Suspended solids range between 150 and 300 mg/l, frequently attaining as much as 500 mg/l. Fluvial matter is mainly comprised of silt and clay in the outermost area of the river, forming drifts throughout the Uruguayan and Argentinean riverbanks, depending on the movement of waters (Bonetto & Hurtado, 1998).

The largest demographic and industrial concentrations of both Argentina and Uruguay are settled in the La Plata River banks. As a result, the river receives waste and wastewater, both of which lead to considerable pollution and eutrophication. These factors chiefly affect a southern coastal strip which extends from Buenos Aires to 3000 m into the watercourse. This strip, whose waters have acquired a blackish colour, has acute pollution and eutrophication rates, which are nevertheless attenuated by the important dilution capacity of the rivers (Bonetto & Hurtado, 1998).

- <u>Paraná River</u>

From its headwaters, the river has low salinity (virtually 45-50 S cm^{-1}) and a basic chemical composition of bicarbonate, calcium, magnesium and sodium. The salt content increases as a result of Paraguay River contributions, especially during the high flows of the Bermejo River. Likewise, the upper and higher Paraná stretches have low levels of suspended solids, despite their high turbidity and their remarkable red hues, which are the result of an extremely fine granulometry (Bonetto & Hurtado, 1998).

- Uruguay River

The Upper Uruguay River (up to the cities of Concordia and Salto) has effective surface hydrological activity throughout its basin, with variable flows from its tributaries. Erosion processes are generally low in the active basin, with an approximate total amount of 17,000,000 tons/year. However, the water is virtually devoid of transparency, and Secchi disc visibility varies locally between 20-80 cm upstream from the beginning of the Argentinean-Brazilian boundary, and 10-45 cm near Colón City (Argentina), 216 km away from the river's mouth (Bonetto & Hurtado, 1998).

Water salinity is quite low, and increases slowly as the river flows downstream, with conductivity in the range of 30-80 S cm^{-1}. The river's pH fluctuates between 6.5 and 8 units, and O_2 levels are high, particularly in the active basin, where over-saturation values can frequently be observed. In Salto Grande, phosphates were detected at a range of 0.002-0.14 mg/l, whereas nitrates were between 0.8-2 mg/l and tended to become scarce downstream (Bonetto & Hurtado, 1998).

3.2. Data and information on water resources

In general, meteorological agencies gather hydrometeorological data, whereas the agencies dealing with water resources gather hydrometric data. Environmental agencies, on the other hand, gather water quality data. Table 3.8 shows the availability of hydrological observation stations in the hydrological monitoring network, by country.

Table 3.5. La Plata River Basin. Number of hydrological observation stations in the monitoring network

Country	Hydrometeorological***	Fluviometric*	Sediments	Water quality
Argentina	115	174	16	13
Bolívia**	---	---	---	---
Brazil	826	521	163	163
Paraguay	119	85		
Uruguay	No information available	82		

Notes: * Fluviometric stations measure river stages and discharges exclusively; ** There are no national information systems, and information is scattered across agencies and projects; *** Hydrometeorological stations include weather and rainfall observation stations.
Source: Tucci, 2004.

3.2.1. Observed weather variation and long term projections

In the 20th Century, the La Plata Basin used to be the sub-continental region with the highest positive precipitation trend in the world (Barros *et al.,* 2004). Rainfall variability in most of southern South America has important interdecadal components. The strongest interdecadal variability in the annual cycle of precipitation occurs in regions of transition between precipitation regimes, especially in the Paraná River Basin. In subtropical Argentina, annual precipitation also shows oscillations with periods from 7 to 10 years. On this time scale, there is a close relationship between temperature and precipitation regimes (Baetghen *et al.*, 2001).

Precipitation trends in Argentina have been positive since 1916 and even increased after the late fifties. This behaviour is consistent with a climatic jump around the 1960s, when the southern portion of South America experienced significant warming. Precipitation increased by up to 30% between 1956 and 1991 in several areas between 20° S and 35° S east of the Andes. In a large part of this region, most of the increase occurred during the 1960s, and it seems to have been associated with a reduction of the meridional gradient of surface temperature, which probably caused a southward shift of regional circulation. Consistently, the leading principal component of annual precipitation correlates with the meridional gradient of temperature at interannual as well as interdecadal timescales (Baetghen *et al.*, 2001).

Another strong precipitation increase was observed during the late 1970s. This correlates with an increase in the subtropical temperature of the Southern Hemisphere. The positive trend in precipitation during 1956-1991 has facilitated a southward extension of the agricultural frontier in Argentina, increasing available lands by the 1960s in an amount that exceeds 100,000 km^2 (Baetghen *et al.*, 2001).

Trends in precipitation over the basin prior to the 1960s have also been detected. A linear trend has been reported in the monthly and annual rainfall in part of the province of Buenos Aires. Decreased precipitation in subtropical Argentina tends to be associated with enhanced westerly flow in Patagonia. The negative trend in the subtropical region in the 1931-50 period could be associated with a slowing of the westerlies over Patagonia. Significant negative correlations have been obtained between westerly flow and rainfall in eastern Argentina (Baetghen *et al.*, 2001).

The increase in precipitation has gone hand-in-hand with a similar trend in the rivers' flow rates. The biggest increase in precipitation occurred between the 1960s and the 1990s. Besides, extreme precipitation in Argentina has increased remarkably in frequency since the end of the 1970s, so much that it has tripled in some cases. It should be mentioned that such events lead to local floods when the conditions of the terrain hamper runoff or concentrate it in specific places (Barros *et al.*, 2004).

Mean annual flow rates in the three largest rivers of the La Plata Basin reveal the onset of a markedly positive trend since the beginning of the 1970s. Floods of all sorts have also become more frequent. Over 80% of the most significant high flows in the Paraná and Paraguay rivers during the 20th Century were observed in the past 30 years, which bears proof to the high impacts produced by regional climate change on the intensity and frequency of floods in the larger rivers of the basin (Barros *et al.*, 2004).

A question naturally arises: will these new hydrological conditions remain as they are, will they become exacerbated in future decades, or will they be restored to their previous status? Understanding the potential connection between these trends and climate change might help to answer this question, because climate change will continue to be observed in future decades. Establishing this link would make it possible to draw conclusions on the timing of the new conditions and detect the signs of future trends (Barros *et al.*, 2004).

3.2.2. Trends of water resources through time

The La Plata Basin has been permanently influenced by climate variability, with consequent variations in river levels. Fluctuations have reached extremes, frequently producing high and low water stages. The basin's flows rate –especially in the Paraguay, Paraná and Uruguay rivers– had a negative trend from 1901 to 1970, but reversed after this period. Variability across decades has also been observed in the basin's discharge patterns. Moreover, there are written reports of alternating flood and drought periods during the 16th and the 18th centuries, which bears proof to a marked natural variability (IPCC, 2001).

In sub-tropical Argentina, Paraguay and Brazil, rainfall has exhibited a long-term change, with a sharp increase between 1956 and 1990, after a dry 1921-1955 period. In the Argentinean plains a positive precipitation trend was observed between 1890 and 1984. This trend in annual precipitation was accompanied by a relative increase in rainfall in spring and summer (IPCC, 2001).

Precipitation is the main driver of variability in water balance through space and time, and changes in precipitation patterns entail significant consequences for hydrology and freshwater resources. Flood frequency is affected by interannual precipitation variability and by changes in short-term characteristics. Changes in seasonal rainfall distribution and interannual variability of low and high flow rates produce a major effect on low water stages and lengthy droughts (Baetghen *et al.* 2001).

Even though the way in which global warming may affect the frequency and intensity of extreme events is still uncertain, extraordinary combinations of hydrological and weather conditions have historically unleashed disasters in some parts of the La Plata Basin. This natural variability must be added to the potential impact of climate change resulting from human activities. Several settlements lying on the banks of the larger rivers of the basin –especially in the Northeast of Argentina– have been affected by floods (Baetghen *et al.* 2001).

An increase is expected in the frequency and magnitude of extreme events such as floods in connection with El Niño, since the La Plata Basin is one of the most sensitive regions to this phenomenon. Evidence has been gathered on the increasing flow rate anomalies observed in the La Plata Basin during recent El Niño events. The maximum monthly discharge patterns in the Paraná River increased by twofold and six fold vis-à-vis normal values during El Niño events occurring in 1982-1983, 1992, 1994 and 1997-1998 (Moyano, 2001). In previous El Niño events (1902-1977), the Paraná River flow rates had been between one and two times above the normal maximum monthly values. Despite the fact that the impact of El Niño varies in magnitude, it has been suggested that its frequency has increased in recent years (UNEP, 2004).

3.2.3. Extreme events

3.2.3.1. Floods

In the La Plata Basin, floods are caused by three main factors: a) the natural high flows that rivers have during the rain season; b) haphazard urban growth, and c) the increase in groundwater tables (Tucci, 2004).

- Riparian floods

The impact scenario shared across South America is a consequence of the occupation of floodplains by the population, during a period with low maximum annual levels of waters. When the years with major floods returned, the damaged increased and the population started to demand that governments take action through building of control works, such as dams, among others (Tucci, 2004).

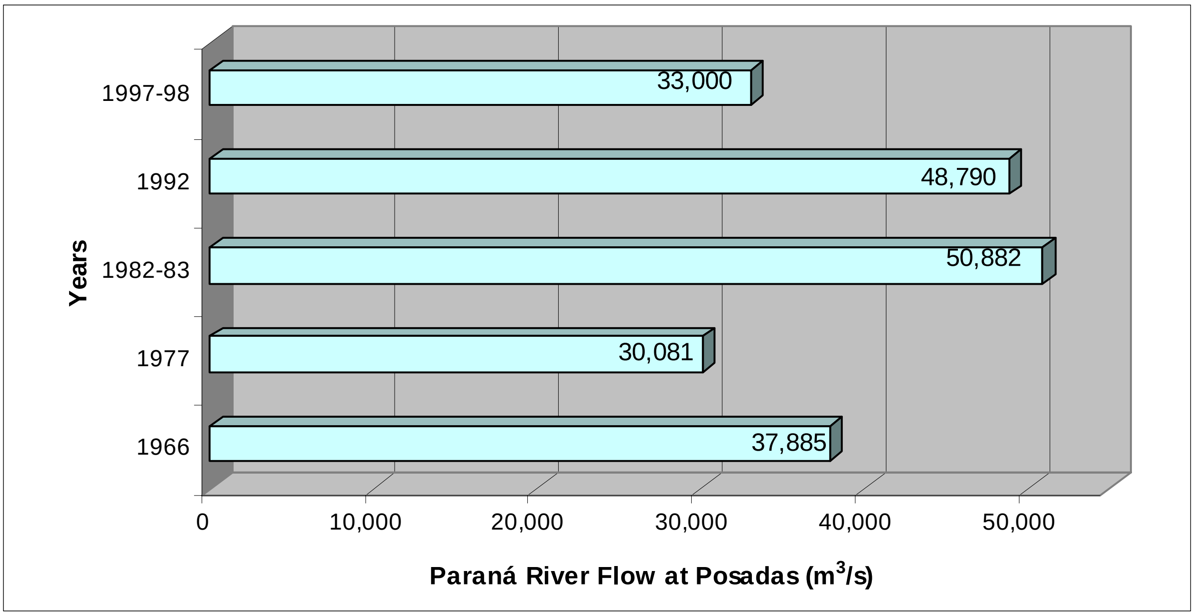
In the Paraguay Basin and the lower stretch of the Paraná River, floods are the result of lengthy rain periods, which affect large areas and produce high flows during many months. In the Argentinean sector, the flatness of the topography makes the water remain for several months. In the upper zone of the Paraná and Uruguay rivers, floods are abrupt and last just a few days.

In Brazil, the Iguazú River had only one flood exceeding the five-year return period between 1959 and 1982, in União da Vitória City (Tucci, 2004). In Uruguay, all 19 departments have been subject to some type of flood between 2001 and 2004, being the departments of Artigas, Tacuarembó, Cerro Largo, Durazno and Paysandú the more affected ones (Genta *et al.*, 2004).

Since 1970 flood episodes have increased in frequency, occurring every four years in average. This increase has been attributed to El Niño phenomenon, and to the influence of land use in the upper basin. As a consequence, the need for zoning the risk in land occupation has become evident, as has the urgency to establish flood prevention measures (Tucci, 2004).

Figure 3.5 shows the river flows of the Paraná River at Posadas station (Argentina) during the major El Niño events in the Northeast of Argentina. As the Table shows, the higher river flow value was reached during 1982-83 El Niño, when the mean annual river flow value was surpassed in almost 40,000 m^3/s.

Figure 3.5. Paraná River. River flows at Posadas during the last El Niño events



Note: the mean annual flow of Paraná River at Posadas is 12,406 m^3/s.
Source: UNEP, 2004.

- Urban Floods

Most of the cities with more than 20,000 inhabitants are subjects –in one way or another– of the floods resulting from urbanisation. Urban development as well as soil waterproofing has reduced water infiltration, so that water runs through streets and drainage pipes. This process has created an increase in the flood flow rate, which has risen as much as sevenfold compared with past flow rates, as in the case of the Curitiba Metropolitan Area located in the bank of the Iguazú River (Brazil) (Tucci, 2004).

Other major cities that face this problem in the La Plata Basin are São Paulo, Campo Grande, Cuiabá and Campinas (Brazil); Asunción and Encarnación (Paraguay); Buenos Aires, Santa Fe, Resistencia and Rosario (Argentina).

Several densely populated cities located in the banks of the Paraná River and its tributaries are quite frequently flooded. In this area, floods are mainly a consequence of inadequate urban drainage, which is unable to transport increasing water volumes. In the Upper Paraná region, the most affected cities are those located on the banks of the Iguazú River (União da Vitória, Porto União and Curitiba) and the Tietê River (São Paulo). Asunción (Paraguay), located in the riverbank of the Paraguay River, is also affected by this kind of flooding (Tucci, 2004).

Major Argentinean urban centres, located both in the banks of the La Plata River (Buenos Aires Metropolitan Area) and the Paraná River (Resistencia, Corrientes) are frequently flooded. Santa Fe City –located in the Paraná and Salado rivers floodplains- suffered the country's worst-ever flood in April-May 2003. Floods in the Argentinean Northeast are strongly influenced by extreme events such as El Niño; the most severe occurred in 1982-83, 1992-93 and 1997-98. In Resistencia, for example, the 1982-1983 flood lasted 11 months (Mugetti, 2004).

In the Buenos Aires Metropolitan Area floods occur in the Reconquista and Matanza-Riachuelo basins, the two most important rivers of the area. In the Autonomous City of Buenos Aires the problem is associated with the overflow of canalised streams as a consequence of convective rains. Another flood triggering factor is the increase in water levels of the La Plata River due to rainy Southeast winds or ocean tides (Mugetti, 2004).

- Water table increases

Increased water tables have been observed in the Pampean region in recent years as a result of both natural and anthropogenic factors. Higher groundwater levels cause problems to underground infrastructure and increase the potential of groundwater pollution in both urban and suburban areas. In rural locations, the upwelling of water leads to floods in large areas used for crop and cattle farming. Despite its association with natural causes –mainly the increase in rainfall after the 1970s– this trend has also been determined in urban areas by anthropogenic factors, inter alias a reduced groundwater pumping capacity (caused by water utility companies, industries and other users); infrastructure developments that obstruct surface water circulation, leading to greater aquifer recharge; a rise in risk water infiltration rates; and inadequate land management (UNEP, 2004).

3.2.3.2. Low Waters

Lengthy low water stages may be a source of economic and social imbalance in the basin. History has shown that many populations in the region were ousted from their settlements as a result of extended drought periods. Even though the climate in the region has been more favourable in the last thirty years, significant low level waters were witnessed in previous years. On the other hand, this favourable situation has relegated the planning to mitigate the impacts of critical periods. Thus, there is a considerable lack of forecasting and knowledge on the risk of droughts in the region (Tucci, 2004).

Several historical series of the Uruguay River reveal that between 1942 and 1951 rainfall was far below the mean. As this area produces most of the agricultural products in the region, the occurrence of a dry period such as the one just mentioned might lead to a variety of impacts. The Paraná River also experienced a dry period, which happened between 1952 and 1956 (Tucci, 2004).

The historical series for the Paraguay River between 1960 and 1973 has already been mentioned. River levels were then much lower vis-à-vis the century's previous and subsequent periods. Minimum levels exhibited the same trend and the mean water level in the Pantanal was nearly 2 m below those observed in previous times. Although extensive flood areas were used during these drier periods, the Pantanal had frequent reductions in its flooded area, all of which modified its environmental conditions; for example, humidity reduction might transform the marshland into a savannah (Tucci, 2004).

3.2.4. Brief data evaluation

Information on the use of river resources, hydraulic works, drinking water and sanitation systems, energy, navigation, irrigation, etc., is scattered across several governmental and non governmental institutions. The riparian countries lack a consolidated database on water and infrastructure in the basins.

The following key problems have been identified (Tucci, 2004):

- Information is scattered across several agencies;
- It is difficult to access the information available in some institutions, so that the basin cannot be studied in depth;
- The amount of sediment and water quality data is limited: observations in some sections have been made in a sporadic fashion;
- There is not a consolidated national data gathering network in Bolivia;
- The number of telemetering stations for real-time observation of hydrological variables is limited.

3.3. Human impacts on water resources

3.3.1. Through surface cover

- Paraná Basin

The main impact of human activity is the change in land uses, which has modified the original vegetation cover. This is particularly the case of deforestation in woods and forests, made to convert extended areas into farming activities.

Besides agriculture, the main causes of deforestation in the Brazilian area of the basin have been cattle-raising, urbanisation, mining and hydropower developments. Until 1970, a significant portion of agriculture in Paraná State and in part of São Paulo State was focused on coffee, which covers soils permanently. After a number of cooler years –when frosts affected the coffee plantations–, coffee was replaced by annual crops like soybean, wheat and maize; this change increased soil erosion in rural areas. In the 1990s, and more markedly after 1994, a new change was introduced, and extensive areas switched to no-till. This has enabled recovering soil’s infiltration capacity, and has increased groundwater levels.

The construction of the Itaipú dam has fostered the expansion of farming areas from Brazil to Paraguay, leading to deforestation. Already in the 1990s only 7% of Paraguay’s natural forests remained. A similar problem is occurring in Bolivia: around 100,000 ha of forests are cut down every year, especially in the Chaco Region (Tucci, 2004).

Another impact of land use on water resources is the sedimentation from agricultural practices; this impact is higher in areas where the soil favours erosion processes. For example, in the middle Paraná River Basin (Argentina), the erosion rate is lower than 10 t/ha/year, meanwhile in the Bermejo Basin is 390 to 2,000 t/ha/year, mainly of natural origin. The sediments in the Bermejo River account for close to 70% of suspended solids in the Paraná River in front of Corrientes City (Argentina) (UNEP, 2004). River erosion is quite advanced in the Argentinean provinces of Chaco and Misiones, whereas wind erosion occurs in the Northwest of the provinces of Buenos Aires and Corrientes.

Finally, the large urban centres located at the Southeast of Brazil (São Paulo and Curitiba) are mainly expanding on the periphery, towards spring areas. This process reduces surface and groundwater availability as a result of the lack of control of urban space by municipalities. Similar situations can be observed in the Argentinean cities of the basin (Tucci, 2004).

- Paraguay Basin

The Pantanal is being impacted by soil degradation in the headwater zones of the Paraguay River tributaries, such as the Taquari River. There has been a substantial intensification of land use for soybean production over the past 15 years, which has led to a considerable amount of sediments in the Pantanal. Similar problems have been observed in the Bermejo River in Argentina, on account of its particular characteristics –such as the steepness of its mobile bed–, which has been influenced by anthropogenic actions throughout the basin (Tucci, 2004).

Other activities produce environmental impacts in the Pantanal. Such is the case of navigation, livestock raising and ecological tourism. When it is inadequately planned, the last practice might cause several environmental damages and impacts on rural population's life quality (Dias Coelho, 2004).

Besides the impacts produced by soybean farming, one of the world's largest livestock raising is located in the Paraguay River's Planalto. This practice leads to soil compacting and hence to a reduction in rainwater infiltration and an increase in surface runoff. In addition, mining in the Mato Grosso has caused soil degradation and water pollution with mercury (Dias Coelho, 2004).

The situation of the right bank of the Paraguay River is different because both human pressure and water availability conditions are lower (Monte Domecq, 2004).

- Uruguay Basin

In the upper and middle Uruguay River basins (Brazil), rural areas are entirely devoted to annual crops, as soybean, maize, wheat and rice. Soybean crops produce soil erosion, which is the main source of diffuse pollution (Tucci, 2004).

In a large portion of the Brazilian South, agricultural practices have increasingly shifted towards no-till, which caused significant benefits in terms of erosion reduction, an increase of groundwater contributions into rivers, and a better regulation of flow rates (Tucci, 2004).

Other water-related conflicts result from rice irrigation in the basin. This is the conflict on water use between agricultural practices and human consumption in some areas of Brazil. Such a conflict is accentuated when agricultural demand is very high, as is the case of flood-based rice farming (Tucci, 2004).

Meanwhile, soils in Uruguay are better conserved as a result of the dominance of livestock farming on both the Uruguay and Negro basins (representing the 74.4 and 77.8% of total areas, respectively). Forests –which account for 5% of the Uruguayan territory–, are another source of soil protection. The worst water-related impacts are related to water uses for rice farming, just like in Brazil (Genta *et al.*, 2004).

3.3.2. Through dams and other works

The construction of a large number of reservoirs in the main rivers and their tributaries has led to the transformation of lotic systems into lentic or semi-lentic ecosystems. Riparian ecotones have been turned into lake ecotones, with a considerable extension of their total length; terrestrial habitats have been destroyed by water that has turned them into littoral habitats. Such transformations account for a loss in excess of 30% of international river length. As many of these reservoirs are international developments, loss of ecosystem has affected the territories of all the countries involved (UNEP, 2004).

- Paraná Basin

The reservoirs in a cascade lying in the international stretches of the Paraná River (Argentina, Brazil and Paraguay) and its tributaries have altered habitats and interrupted the continuity of freshwater systems and their communities, affecting the demographic structure of migratory species of a high biological and commercial value (UNEP, 2004). One of these impacts is the so-called “gas bubble disease”, originated by super saturation of gas caused by the passage of water through the reservoirs’ spillways; this disease produces bubbles inside the blood vessels of fish living downstream the dam. The disease has been detected at Yacyretá reservoir (Argentina-Paraguay), where Siluriforms can be counted as the most affected species (Tucci, 2004).

Although no quantitative indicators on the extent of habitat transformation are available yet, some researches establish that over 35% of the total length of the Paraná River –about 2,570 km– has been altered by the construction of large reservoirs such as Ilha Solteira, Jupia and Porto Primavera (Brazil), Itaipú (Brazil-Paraguay) and Yacyretá (Argentina-Paraguay). Many reservoirs have also been built on the tributaries of the Paraná River, in the Brazilian territory. In this area, there has been a dramatic transformation of lotic environments into lentic ones, namely 36% in the Tietê River, 46% in the Iguazú River, 48% in the Grande River, and as much as 64% in the Paranapanema River (UNEP, 2004).

In the reservoirs, the fauna is poorer than in the rivers due to the decrease in water velocity and the formation of an extensive pelagic area. As regards the Itaipú Reservoir (Brazil-Paraguay), a number of researchers have described the changes suffered by the fauna after the river closure. Prior to the construction of the reservoir (1978-1981) there were 113 species of fish upstream Saltos de Guayra –where the dam was constructed–; in the following years, only 83 species remained (UNEP, 2004).

Reservoirs transform river ecosystems into lake ecosystems, increasing their longitudinal development and changes terrestrial ecosystems into aquatic ones. The sum of reservoir areas by sub-basin is a proxy indicator of such alterations; in the case of the reservoirs lying on the Paraná River, the total area amounts to about 6,800 km^2. The total area of the main reservoirs in the Paraná system, including its major tributaries, exceeds 16,000 km^2 (UNEP, 2004).

In the Iguazú River –and more particularly in its middle zone– several hydropower reservoirs have been built, changing the physical, chemical and biological features of the river. Such reservoirs in a cascade have transformed about 40% of the lotic environments into lentic and semi-lentic ones. Before the commissioning of the Segredo Reservoir, aquatic vegetation had been characterised by rooted plants, whereas floating plants were extremely rare. Nowadays, as the environment has become lentic, floating macrophytes are favoured. Trophic web changes as well as structural modifications in aquatic fauna have been also observed. Such changes might entail dramatic consequences for biodiversity, not only on account of the low amount of species in the Iguazú River but also because of their high endemicity. However, the fish community had already been affected by the Foz do Areia Reservoir, located upstream (UNEP, 2004).

Another interesting transformation indicator is the increase in average annual residence time in river subsystems. Table 3.6 shows, in an indicative way, the situation before and after the construction of the reservoirs, revealing the significant transformations imposed on the natural river environment (UNEP, 2004).

Other impacts of shared hydro developments such as Itaipu and Yacyretá have to do with lake pollution, which affects water supply in cities such as Encarnación (Paraguay) (Monte Domecq, 2004). The same problem can be seen upstream from the reservoirs in Brazil, where water quality is affected as far as the river flow is retained and oxygen concentrations drop (Tucci, 2004).

Likewise, the riparian zones have been transformed as a consequence of urban settlements along the riverbanks. The urban-industrial front of the Lower Paraná River in Argentina extends over more than 100 km (UNEP, 2004). In addition, the big metropolitan areas of São Paulo and Curitiba have brought about substantial losses of natural riparian ecosystems in the Tietê and Iguazú rivers, respectively (Tucci, 2004).

Table 3.6. Paraná River Basin. Changes in average annual residence time in several rivers.

River system	Residence time (in days)	
	Natural*	Reservoir**
Grande	15	695
Paranaiba	14	627
Tietê	12	593
Paranapanema	8	907
Iguazú	15	355
Paraná	30	159

* A mean annual flow rate of $1m^3/s$ has been adopted as a benchmark value
** Calculated on the basis of reservoir volume
Source: UNEP, 2004.

- Paraguay Basin

Navigation on barges along the Paraguay River has degraded forests, river's ravines and meanders. Potential changes in the Paraguay River's bed as a result of navigation along the Paraguay-Paraná Waterway[12] might reduce the amounts of water, sediments and nutrients that drain into the flood plain, thus altering the natural conditions of the Pantanal (Dias Coelho, 2004).

The Paraguay-Paraná Waterway will elevate the river's runoff capacity, increasing flow rates and reducing the availability of water for flood plains. Some researches foresee that such changes could cause deep alterations in the environment during the rivers'low flows (Tucci, 2004).

- Uruguay Basin

The Salto Grande Reservoir –which is shared by Argentina and Uruguay– has modified almost 8% of the Uruguay River's length (Mugetti, 2004). On the other hand, reservoir's flow rate fluctuates, producing a variation in river levels downstream the dam and intensifying erosion on the river banks. Such an effect is even more evident on the gorge-like Uruguayan bank, in the department of Salto, which has severe signs of erosion and degradation. Both phenomena have altered the morphology of this riverbank, and have thus caused serious physical and biological damage in the area (Genta *et al*, 2004).

[12] The projected Paraguay-Paraná Waterway tends to ease fluvial traffic and transportation of diverse products from upstream countries.

3.3.3. Pollutants (organic, heavy metals, chemicals)

- Paraná Basin

The Paraná River has signs of pollution even though its high dilution capacity. The situation is quite serious in the Lower Paraná Basin and specifically in the industrial area of the Rosario-Buenos Aires corridor, where a high fish mortality rate has been observed together with other acute impacts on biodiversity. Near Rosario and Buenos Aires cities (the last one located on the La Plata riverbank), algae concentration oscillates between 15,000 and 300,000 ind/l, and turbidity is in the range of 30-230 NTU. Such values jeopardize the quality of water for human consumption (UNEP, 2004).

The lack of treatment of sewage effluents is a problem affecting the five riparian countries, since only 10% of effluents are treated. The impact becomes evident chiefly near cities such as Rosario (UNEP, 2004). The *Instituto Nacional del Agua*, INA (National Institute of Water) in Argentina has noted a high concentration of toxic algae (*algae cyanophyta*) in 76% of the water samples drawn from the Paraná River. These species develop in warm water contaminated with sewage and industrial wastes, and cannot be eliminated by the regular systems of water treatment for human consumption. The toxins produced by these algae act on the human liver and their effects are cumulative (UNEP, 2004).

Only 15% of effluents are treated in Brazil. Eleven of the thirty most polluting cities lie on the headwaters of the rivers that flow into the Paraná River. This produces an even bigger impact as a result of the rivers' impaired dilution capacity and the limited water availability for human consumption. Domestic organic load in the Brazilian portion of the Paraná Basin is estimated at 2,179 t of BOD5 daily (34.1% of the country's total) and is chiefly concentrated in the Tietê Basin (48% of the total), where the São Paulo Metropolitan Area is located (Tucci, 2004).

Besides domestic waste, the industrial waste originated in these cities should be considered alongside rainwater. The load borne by rainwater drains may amount to values nearly as high as those of domestic waste. São Paulo Metropolitan Area, together with the Piracicaba Basin and Curitiba Metropolitan Area are heavily industrialised areas, where the industrial effluent treatment is more intensive than the domestic one; however, the amount of untreated effluents jeopardizes the rivers in those regions, especially because the more industrialised areas are located on the headwaters. Such is the case of the Alto Tietê River in São Paulo and the Iguazú River in Curitiba (Tucci, 2004).

Some of the farming-related industries must be highlighted as far as industrial effluent dumping is concerned: alcohol production, poultry breeding and pig farming. The former has expanded as a result of the alcohol-for-fuel program; although its share has decreased over the past few years, it is still producing significant impacts on freshwater quality, particularly in São Paulo State. Food industries, whose presence in the West of Santa Catarina State is strong, have also expanded into the states of Paraná, Mato Grosso do Sul and Goiás (Tucci, 2004).

The untreated effluents pollute the springs, reducing the safety of water supply systems and increasing the need for bigger investments in treatment systems. This process occurs mainly in the bigger Brazilian cities of the basin. For example, São Paulo City is affected by chronic water supply issues, which have arisen with the increase in demand and the lack of safe sources for attending expansion; such a situation will tend to worsen as urbanisation continues to grow. The shutdowns of water treatment systems due to pollution and population's complaints about foul smells (caused by algae blooms) are frequent in the Tietê River Basin (Tucci, 2004).

- Paraguay Basin

The Paraguay Basin has the same pollution problems observed in the Paraná Basin, although the magnitude of the impact is different. In the case of urban and industrial activities, pollution occurs as a result of the direct dumping of untreated waste or through septic tanks that pollute the aquifers. For example, the pollution of the Cuiabá River and the public water distribution issues have led to profound irregularities in water supply in Cuiabá City (Brazil). The organic load from domestic pollution is estimated at 74 t of BOD5 daily, and is concentrated in the vicinity of the Cuiabá/Várzea Grande Metropolitan Area, in the Upper Cuiabá Basin (44.6% of the total pollution in the basin). These problems are also evident in the major cities of Paraguay (Tucci, 2004).

Water pollution also results from soybean crops and extensive stock farming in the Planalto (plateau) area of the Paraguay River in Brazil. Besides the increase of erosion and sedimentation on the riverbeds, pollution in these watercourses can also be accounted by the use of pesticides in agriculture (Tucci, 2004).

Pollution from mining can also be observed in this basin and particularly in the two main tributaries' basins: the Bermejo and Pilcomayo rivers. In Bolivia, mining is practised mainly in the upper basins of these two rivers, which results in pollution by wastewater originated by extraction and processing activities, and by mine erosion. Acid drainage has been estimated at approximately 4,000,000 m^3, and is related with the dumping of 643,000 t of total solid waste (Tucci, 2004). In Brazil, mining in the Paraguay River's Planalto results in pollution from mercury deposits on the river's sediments (Tucci, 2004).

Finally, in Argentina, oil waste pollution has been detected in the sub-basin of the San Francisco River –an affluent of the Bermejo River–, and heavy metal pollution has been observed in the Pilcomayo Basin. High concentrations of lead, arsenic, copper, mercury and silver have been encountered in Misión La Paz (Argentina) (UNEP, 2004).

- Uruguay Basin

In the Uruguay Basin, pollution results from the dumping of domestic waste and industry and farming by-products.

In the first case, the urban domestic waste originated by all the Brazilian cities of this basin is dumped into the river system without any treatment whatsoever, creating unfavourable conditions in most of the rivers that run through urban settlements. In the Lower Uruguay River, the mean and median values of faecal coliforms are higher than water guide values, ranging between 4 and 480/100 ml. This hampers recreational activities in a large area of the watercourse (Tucci, 2004). In the Upper Uruguay, human organic waste dumped into the watercourses of the basin amounts to 135.3 t of BOD5 daily (Dias Coelho, 2004).

Salto, Paysandú and Fray Bentos –the three biggest cities located on the Uruguayan bank of the river– have no waste's treatment. Even though the river has a sufficiently high dilution capacity to absorb the load discharged by the cities, waste dumping produces coastal pollution that extends for a number of kilometres. Paysandú is the city faced with the worst situation, with a permanently bacteriological pollution in its beaches. This situation is exacerbated by the high waste dumping from the industries in the area (Genta *et al.*, 2004).

In Brazil, the most industrial pollution sources are located on the banks of the Peixe and Canoas rivers (Upper Uruguay River Basin). Pollution in the Peixe River is diffuse as a result of industrial activities in Santa Catarina State; the effluents are originated by paper and pulp factories and food processing plants. Waste dumping has raised hand-in-hand with increased production, industrial outsourcing and the difficulties of treating small-sized discharges (Dias Coelho, 2004).

The use of agrochemicals in rice paddies along the basin of the Ibicuí River has also altered water quality in the superficial springs used for human consumption, which results in higher water treatment costs. On the other hand, rise in sediment concentration and in long-term mean flow rate are two of the effects of deforestation, which has been practised with the goal of converting wooded areas into arable land suitable for annual crops (Dias Coelho, 2004).

Pollution by toxic algae has been detected recently. This phenomenon has been increasingly evident since 1997, both on the Uruguayan banks of the Uruguay River and the La Plata River. Algae development has mainly involved cyanobacteria, which include a number of toxic species, such as *Microcystis aeruginosa*, which under certain conditions may produce negative effects on human health. Even though the causes for the development of these algae have not been fully studied, they seem to lie at reservoirs located both in the Uruguay –Salto Grande– and Negro rivers, where algae blooms have been registered (Genta *et al.*, 2004).

Finally, pollution has been detected in the sedimentary aquifers of the Uruguayan milkshed, more particularly in the departments of San José, Colonia and Soriano, where nitrate increases have been observed. Even though the causes of such an impact are diverse, it is not possible to determine the main factors involved yet. In any case, potential nitrate sources in the aquifers may be the leaching of organic matter –which decomposition releases nitrates– and organic matter coming from sewage or from dairy farms. Leaching resulting from excessive fertilisation in agriculture is a less relevant source of nitrates in aquifers (Genta *et al.,* 2004).

- La Plata Basin

The La Plata River is an open system whose chemical and river features make it vulnerable to pollution; the river receives domestic, agricultural and industrial effluents. Water pollution depends on transportation of pollutants due to river dynamics –resulted from the interaction of the Atlantic Ocean and river flows coming from the basin– and on loads' dilution and accumulation capacity. The river's sediments accumulate pollutants through time, which are retained as suspended matter; thus, sediments are samples of recent discharges.

In Buenos Aires Metropolitan Area, industrial and rain-drainage pollution has caused the presence of heavy metals and Persistent Organic Pollutants (POPs) (UNEP, 2004), being the latter distributed across the river's biota. Polychlorinated biphenyls (PCBs) have also been identified. As far as organic pollution is concerned, oxygen demand is higher in the areas closer to the mouth of the Riachuelo River and in Punta Colorada, where less dissolved oxygen is available. The highest bacterial concentration can be found 500 m away from the coast, where total coliform bacteria and faecal coliform bacteria are over US EPA's recommended values. In 1997 a geometric mean of 12,000/100 ml of faecal coliform bacteria was measured in front of the Riachuelo River mouth (Mugetti, 2004).

Montevideo Metropolitan Area is the most polluted region in Uruguay, affecting most urban watercourses, whose flow rates are low and whose basins are both small and heavily urbanised. These streams have a virtually permanent lack of oxygen, as well as considerable amounts of solid waste along their banks. Three sources of pollution have been identified: sewage disposal from the sewerage system, industrial effluent discharge and municipal solid waste disposal (Genta *et al.*, 2004).

The riverbanks of Montevideo as well as those of other cities have been impacted by sewage discharges and the presence of solid waste. This coastal strip receives effluents directly as well as indirectly, through tributary streams and groundwater contributions from a population that exceeds 1,500,000 inhabitants. Most of these effluents are dumped with little or no treatment. Despite this situation and the large amounts of organic matter dumped in the La Plata River bank every day, the only perceivable sign of pollution is bacterial contamination in the beaches of Montevideo and Canelones, especially after rainfalls (Genta *et al.*, 2004).

Farming-related pollutants –such as chlorinated pesticides– are thrown into the basin at the South of Buenos Aires Metropolitan Area. POPs and PCBs have been found in the biota of the Samborombón Bay, revealing pollution in the water column and the sediments. POPs enters the bay due to farming and industry contributions from the nearby area. These compounds are dispersed by water currents and winds within the La Plata River, and eventually attach to both sediments and biota. PCBs have also been detected in the water and fish of the lagoons located in the Upper Salado River Basin (Mugetti, 2004).

Finally, algae blooms have been detected in the beaches of both departments of Montevideo and Canelones (Uruguay). Their growth might be stimulated by the nutrients received from wastewater discharges. The same phenomenon has been observed in two reservoirs of the Santa Lucía Basin, as a result of phosphorous content. This problem may be caused by the effluents generated by crop and dairy farming and eventually absorbed by the basin. These reservoirs supply water to the city of Montevideo, so algae blooms affect their drinking water production (Genta *et al.*, 2004).

3.2.4. Non-native species[13]

The main problems related with non-native aquatic species have to do with the introduction of the golden mussel (*Limnoperna fortunei*), a bivalve mollusc native to Asian rivers that arrived in South America in the ballast water of vessels. This invasive mollusc settled first in the La Plata River, in front of Buenos Aires, in 1991. Then, travelling on the vessels' hulls, it spread to the Paraná River, and it was thus that it arrived in Brazil. The first records of observations of golden mussels in the Brazilian territory dated from January 1999, when this bivalve was found on the beach of Itapuã (Rio Grande do Sul State). The successful invasion by this mollusc can be explained by the fact that there are no natural predators of this species in the rivers of the La Plata Basin (Dias Coelho, 2004).

[13] The common names of fish and other aquatic fauna have been translated into English. However, some local common names have no possible translation; thus, original Spanish or Portuguese names were maintained. In all the cases, scientific names are given between brackets

Once it attaches to different components of water facilities, the golden mussel becomes a problem for water treatment systems (such is the case of Punta Lara, on the Argentinean bank of the La Plata River), because it reduces pump efficiency and alters general operations. In 2001 the mollusc was detected in one unit of the Itaipú hydropower plant. For dams, the main problem is the obstruction of pipes and turbines, so that maintenance has to be performed more frequently, with the resulting economic and environmental impacts (Dias Coelho, 2004).

The golden mussel is also thriving in the Uruguay River and its main tributary, the Negro River (Genta *et al.*, 2004), and has recently been detected in the Paraguay River (Crespo Milliet, 2004).

Another outstanding invasion has been the introduction of the carp *Cyprinus carpio* in the small lagoons of the Entre Ríos Province (Argentina) (Mugetti, 2004). This species has also been detected in the lower Uruguay River and the La Plata River, where it has significant biomass values. The actual or potential impact of carps in the river's systems has not been assessed yet (Genta *et al.*, 2004). The same happens with the yellow clam (*Mesodesma mactroides*), species that has already become dominant in the inner zone of the La Plata River and the lower Uruguay River.

3.2.5. Over-harvesting

Latin-American rivers have remarkable fish biodiversity, with migratory species of economic value such as "sábalo" *(Prochilodus lineatus),* "boga" *(Leporinus),* "patí" *(Luciopimelodus)* and "surubí" *(Pseudoplatystoma)*. Their migratory cycles have a remarkable influence on the trophic structure of the fish community. "Sábalo" is one of the key species in the system because its eggs and larvae are the basis of the food web (UNEP, 2004).

- Paraná Basin

A reduction in catfish *(Rhinelepis aspera*) stock has been observed in the Upper Paraná River, where its catch has decreased by 70%. Over-exploitation of granulated catfish *(Pterodoras granulosus),* "manguruyú" *(Paulicea lüetkeni)* and spotted sorubim *(Pseudoplatystoma coruscans)* has also been reported in the Itaipú Reservoir. In this reservoir, fishing effort amounted to 67.5 days in 1987, 120 days in 1993 and 106.5 days in 1998. The optimal recommended rate is 95.5 day per year. There has been a decrease in the Catch per Effort Unit, with a daily catch of 21.7 kg in 1987, 15.5 kg in 1992 and 11.5 kg in 1998 (UNEP, 2004).

There are indicators of "pacú" *(Piaractus mesopotamicus*) and "manguruyú" *(Paulicea lüetkeni)* over-harvesting in the Brazilian portion of the Paraná and Paraguay river basins. The decrease in "pacú" *(Piaractus mesopotamicus)* stock in the lower zone of the Paraná and Uruguay rivers is a consequence of deforestation.

Likewise, there is some evidence of "sábalo" (*Prochilodus lineatus*) over-harvesting in the Middle Paraná River, since its catch rate is twice or three times higher than it used to be. As there are about 200 recorded species that feed on "sábalo", the drop in its stock might lead to the extinction of invaluable resources. The more frequent catches are fish under four years old, younger than the allowed minimum; this affects the likelihood of recovery for "sábalo" populations (Oldani *et al.* 2001).

There is also some evidence of a decrease in the harvest rate of some fish species downstream from the Santa Fe-Paraná axis, in Argentina: such is the case of the tiger shovelnose catfish (*Pseudoplatystoma fasciatum*) and “pacú” (*Piaractus mesopotamicus*). “Sábalo” (*Prochilodus lineatus*) and “dorado” *(Salminus maxillosus)* have seen their mean size reduced, and biomass over-exploitation has also been observed. Species such as “armado chancho*” (Oxydoras kneri*), silverside (*Odontesthes bonariensis*), salmon (*Brycon orbignyanus*) and “manguruyú” (*Paulicea lüetkeni*) have been dramatically reduced, and some species have remained unrecorded for years. Many reasons might explain this phenomenon; the local experts entertain controversial opinions, and refer to such diverse factors as over-harvesting, environmental impacts of dams on migration, loss of habitats suitable for reproduction, deforestation, pollution, etc. (Oldani *et al.* 2001).

Finally, selective fishing in local areas of the La Plata Basin might produce changes in community structure and dynamics, because the most valuable sport and commercial species like “surubí” (*Pseudoplatystoma sp)* and “dorado” *(Salminus maxillosus)* are the main target.

The lake conditions in the Itaipú reservoir have led to an increased density of piranhas (*Serrasalmus spilopleura*), which has forced fishermen to use gill nets, increasing both the number of species caught and the amount of by-catch, and reducing overall profitability. Trawling is the most common fishing practice, and lines with several fishhooks or nets are used only for minor small-scale and land-based fishing practices (UNEP, 2004).

- <u>Paraguay Basin</u>

In the Upper Pilcomayo River, high inter-annual variations in the catch of valuable species have been reported. “Sábalo” *(Prochilodus lineatus)* fishing is a clear example, with the average catch dropping from 1,000 t/year in 1980-1989 to 400 t/year in 1990-1998, and hitting a low of as little as 100 t/year in certain years. The Bolivian Red Book of Vertebrates has classified “sábalo” as a vulnerable species. Despite the decrease in Pilcomayo flow rates in the 1990s, which might have affected “sábalo” availability, the reduced catch rate might also be due to a combination of over-harvesting and recession in the Lower Pilcomayo, all of which has isolated upstream populations and thus made them more vulnerable (UNEP, 2004).

Commercial fishing in the Pilcomayo River is chiefly practised by aboriginal peoples of Argentina, Bolivia and Paraguay, and involves different methods such as traps, nets and explosives (UNEP, 2004).

- <u>Uruguay Basin</u>

Critical conditions have been detected for some species in the Uruguay River. Such is the case of “pacú” (*Piaractus mesopotamicus*), “manguruyú” (*Paulicea luetkeni*), “piracanjuba” (*Brycon orbignyanus*), and tiger sorubim (*Pseudoplatystoma fasciatum*). The harvesting of these species has been forbidden by a resolution adopted by the *Comisión Administradora del Río Uruguay,* CARU (Administrative Commission of the Uruguay River) (CARU, 1998). In 2000, as a result of the critical situation of other species in the river, CARU established new minimum harvest rates for 10 species, which include some of economic value such as “dorado” (*Salminus maxillosus*) and spotted sorubim (*Pseudoplatystoma coruscans*), as well as other species, like “sábalo” (*Prochilodus lineatus*), which are key species in the ecosystem (CARU, 2000 a).

The construction of the Salto Grande dam has produced changes in the abundance and composition of species, and the sluices have not played a significant role in preserving migratory fishes. In the Negro River reservoirs, the species most heavily harvested are "tararira", yellow catfish and black catfish, whereas the "dorado", "boga" and "sábalo" – typically migratory species– have ceased to be harvested. It is expected that the construction of new reservoirs upstream from the existing ones will have profound effects on the existing communities. According to *The World Conservation Union (IUCN)*, most annual fish species native in these basins are seriously jeopardized (Genta *et al.*, 2004).

PART B- GOVERNANCE ISSUES

Challenge: Governing Water Wisely

Overview: Good governance is necessary to ensure the involvement of the public and the interests of all stakeholders are included in the management of water resources.

4. Governing water wisely in the La Plata Basin

- Argentina

Argentina is a republic, its government system is federal and representative, and its territory is divided into 23 provinces (with nearly 2,000 municipalities) plus the Autonomous City of Buenos Aires. According to the Constitution, "the provinces retain all powers not entrusted herein to the Federal Government, as well as those expressly reserved for them in special agreements at the time of their creation".

After the 1994 constitutional reform, it was set forth that "the original ownership of natural resources in the provincial territories pertains to the relevant provinces". Likewise, jurisdiction, i.e., the power of ruling on the relationships emerging from the development, protection and conservation of these resources, pertains to the provinces, because it is a power that, being inherent to ownership, becomes effective and meaningful through the exercise of such ownership. With regard to inter-provincial rivers, the jurisdiction is again provincial, and all matters related with them must be regulated by means of treaties.

The principle of jurisdiction makes an exception for the powers that have been expressly transferred by the provinces to the National Government. In terms of matters related, either directly or indirectly, with water resources, the Constitution has established that the National Government retains jurisdiction over navigation, inter-provincial and international trade, international affairs and treaties, maritime jurisdiction and admiralty dues, and over the writing of the Codes of Civil, Criminal, Mining, Commercial, Labour and Social Security Law.

The 1994 reform added Section 41, which established a number of guarantees for the nation's inhabitants in connection with the environment and natural resources. As water is a natural resource and a component of the environment, it is involved in all environment-related regulations. The third paragraph transfers to the National Government the jurisdiction "over the formulation of regulations involving minimum environmental protection requirements" whereas the provinces are entitled to write "all necessary regulations as required for complementing the former regulations, without prejudice to local jurisdictions".

In addition, a number of concurrent powers exist, the exercise of which pertains, on an equal and simultaneous basis, to both federal and provincial levels. The National Congress has the right of "regulating free inland navigation", and "facilitating prosperity, development and wellbeing both in the entire country and in each and every province", by promoting, inter alia, the construction of navigation canals and the exploration of inland rivers. The latter attributions concur with those of provincial states.

As a result of its complex and dynamic institutional framework, and the scattered nature of its political and legislative affairs, Argentina does not have a nationwide water resources management plan. However, a number of actions have been taken along these lines, e.g., the Master Plan on Water Resources Management, programmed in 1994 by the *Subsecretaría de Recursos Hídricos de la Nación*, SSRH (National Undersecretariat of Water Resources). This document was envisaged as a planning, budget allocation and management control instrument designed to enable rational development and preservation of water resources, facilitate sustainable development, and maintain and enhance quality of living among the country's inhabitants. As a first step, a Preliminary Diagnosis on Water Resources Management in the country was established between 1994 and 1996.

Later, the relevant authorities set out to define and raise consensus on a number of principles on water resources management nationwide (the *Principios Rectores de Política Hídrica* - Water Policy Ruling Principles). These principles were written and discussed by all jurisdictions, following a bottom-up methodology, which enabled consensus to be achieved on the basis of documents generated in the provinces.

These Guidelines led to provincial and regional workshops attended by provincial water authorities and other stakeholders dealing with either water or the environment in general (NGOs, users, academia, farmers' and business chambers, municipalities, community leaders, etc.). Several drafts of the *Principios Rectores de Política Hídrica*, PRPH (Water Policy Guidelines) were produced as a result of these workshops, whose turnout exceeded 3,000 participants. The process concluded with the writing of a preliminary document signed at the *Primer Encuentro Nacional de Política Hídrica* (First National Meeting on Water Policies), which took place in December 2002 and was attended by the relevant national and provincial authorities.

As part of this meeting, the representatives of both national and provincial water-related agencies agreed to form a *Consejo Hídrico Federal*, COHIFE (Federal Water Council), which was formally created on March 27, 2003.

The final document –which resulted from nationwide consensus–, sets forth the guidelines pertaining to the technical, social, economic, legal, institutional and environmental aspects of water as regards the management of this resource with a view to sustainable development. Such Guidelines explicitly adopt the concept of Integrated Water Resources Management, and stipulate several instruments, the most significant of which are water ethics and governance, decentralised and participative management; basins and aquifers as planning and management units; control over negative externalities in water resources management; basin and user organisations and agencies; planning; the right to information; awareness raising, and capacity building. The principles on integrated water management will serve as guidance for legislators when they undertake to write a legal groundwork compliant with modern and efficient management, and will help State administrators to create appropriate organisations and action programs.

Most jurisdictions signed the *Acuerdo Federal del Agua* (Federal Water Agreement) in the City of Buenos Aires on September 17, 2003, whereby they adopted the Guidelines and agreed to submit them before Congress in order to materialise a number of regulations through a National Framework Law on Water Policy. They also undertook to accommodate and instrument such principles within their respective policies, regulations and water management approaches.

Likewise, there are a number of national, regional and local basin management plans, programmes and projects that comprise planning-related aspects and include various approaches. One of the most significant programmes was the *Programa de Desarrollo Institucional Ambiental AR-0065*, PRODIA (Institutional Environmental Management Programme), which was developed by the former Secretariat of Natural Resources and Sustainable Development (renamed as *Secretaría de Ambiente y Desarrollo Sustentable*, SAyDS (Secretariat of Environment and Sustainable Development) and was funded by the Inter-American Development Bank, IDB (1994/99). A component called Institutional Structures for Basin Management was developed as part of this programme, and included pilot experiences in basins located in three different provinces. These experiences involved analysing alternative institutional models designed for streamlining environmental management on a local basis, and used the basin as the physical, conceptual and planning unit.

Another programme worth mentioning is the *Programa Estratégico de Acción para la Cuenca del Río Bermejo* (Strategic Action Programme for the Bermejo River Basin). Such an initiative has been developed by the *Comisión Binacional para el Desarrollo de la Alta Cuenca de los ríos Bermejo y Grande de Tarija*, COBINABE (Binational Commission for the Development of the Upper Basin of the Bermejo and Grande de Tarija Rivers) –shared by Argentina and Bolivia- is funded by the Global Environment Facility (GEF), and includes participation by the United Nations Environment Programme (UNEP) and the Organization of American States (OAS). The goal has been to identify critical transboundary problems and basin needs, and to help the region implement a basin-based approach whose purpose will be to integrate environmental concerns with sustainable development and thus protect and conserve the ecosystem's ecological structure and functioning, both within the relevant watercourses and downstream from them.

Another interesting initiative is the *Plan de Gestión Ambiental y Manejo de la Cuenca del Río Matanza-Riachuelo* (Environmental Management Plan for the Matanza-Riachuelo River Basin), which was launched in 1995 and is being implemented by an interjurisdictional agency comprised of the National Government, the Government of the Province of Buenos Aires, and the Government of the City of Buenos Aires. Its aim is to generate answers to the plethora of causes that lead to pollution in the most heavily impacted urban basin in the country.

In addition, as part of the obligations that must be met by the relevant national authority, Act 25,688 on Environmental Water Management establishes that a National Plan shall be written and regularly updated to preserve, develop and use water rationally. Such a Plan as well as its amendments require approval by the National Congress, and must contain, at the very least, the necessary measures for coordinating actions in the various basins. The Water Policy Guidelines also refer to this topic in the chapters on "Planning and Management Unit" and "Water Planning", the latter of which establishes that each jurisdiction shall develop water management plans, and that all provincial plans must be articulated in a single National Water Management Plan that ensures that the objectives set by the national policy are met.

- <u>Bolivia</u>

In Bolivia, the *Consejo Interinstitucional del Agua*, CONIAG (Interinstitutional Water Council) was created by Executive Order 26,599 on April 20, 2002, with the goal of enabling communication and agreement between the government and social and economic organisations. The aim was to accommodate the water-related legal, institutional and technical framework with a view to planning and regulating water resources management.

The *Dirección General de Cuencas y Recursos Hídricos*, DGCRH (General Directorate of River Basins and Water Resources) encouraged the Technical Secretariat of the CONIAG to coordinate a number of activities oriented towards building a regulatory framework for water resources management. In this regard, a number of workshops enabled identifying and defining significant topics that would lead to the formulation of a National Water Resources Policy. In addition, the blueprints for the rules of procedure of the *Consejos Departamentales Interinstitucionales del Agua*, CODIAGs (Interinstitutional Departmental Water Councils) were submitted to be discussed within the CONIAG member institutions.

On the other hand, International Cooperation was secured for the creation of the National Basin Management Programme, and for the production of the relevant technical and methodological documents, which include the country's River Basins Map, the River Basins Atlas and the River Basins Information System. The project provided for the implementation of pilot programs for priority basins, which would enable validating methodologies and other items that would be introduced as basin management plans are implemented.

Bolivia's general planning framework springs from Executive Order 216,779, enacted in 1996, which sets forth the basic standards for the *Sistema Nacional de Planificación*, SISPLAN (National Planning System). This system was regulated by the *Ministerio de la Presidencia* (Ministry of the Presidency), which replaced the *Ministerio de Desarrollo Sostenible y Planificación*, MDSP (Ministry of Sustainable Development and Planning) in that role. The SISPLAN was mandatory for all State agencies, and took effect on three levels:

- The national level, composed of the Ministers'Council and the Executive Branch Ministries, with their subordinate agencies;
- The departmental level comprised of the Department's Prefect, the Departmental Council and the Departmental Planning Unit.
- The municipal level comprised of the Municipal Government, the Oversight Committees, the Communities and Neighbours Associations, and all national agencies with representation at the municipalities.

The *Plan General de Desarrollo Económico y Social* (General Economic and Social Development Plan) was written at the national level, and was used as a basis for resource allocation. The *Plan de Desarrollo Departamental* (Departmental Development Plan) was created at the departmental level in accordance with the competencies of the department prefects, and should be compliant with the General Development Plan. The *Plan de Desarrollo Municipal* (Municipal Development Plan) –which was the prerogative of each Mayor through the Planning Unit–, was put together at the municipal level.

- <u>Brazil</u>

In Brazil, Law 9,433 (Presidência da República Federativa do Brasil, 1997), enacted on January 8, 1997, established the National Water Resources Policy, and created the National Water Resources Management System. Law 9,984 (Presidência da República Federativa do Brasil, 2000), enacted on July 17, 2000, provided for the creation of the *Agência Nacional de*

Aguas, ANA (National Water Agency), a federal organisation in charge of implementing the National Water Resources Policy and coordinating the National Water Resources Management System, among other activities. Integrated management is clearly defined in the principles and guidelines of the National Water Resources Policy.

The 1988 Federal Constitution sets forth (in § 6, Section 20) that the Nation owns, inter alias, lakes, rivers and any and all watercourses lying within its territory, flowing across more than one State, making a boundary with neighbouring countries, or flowing into or from foreign territory, as well as marginal lands and river beaches, and hydropower potential.

According to the Law (in § 1), either a share or financial compensation "is guaranteed on the proceeds of exploration activities (…) performed on water resources with the goal of producing hydropower (…) in the relevant territory (…) for the States, the Federal District, the Municipalities and National Government agencies".

It is the National Government's prerogative (as per Section 21, XIX) to establish the national water resources management system and to define principles on the awarding of the right to use water resources. It is also the National Government's exclusive prerogative (as per Section 22) to legislate on civil, commercial, criminal, procedural, agricultural and maritime law, as well as on all matters having to do with water, energy and ports, and circulation along lakes, rivers, seas, air and space.

The National Government shares with the States, the Federal District and the Municipalities (as per Section 23) the obligation to protect the environment, combat pollution in any and all of its forms, and oversee research and exploration leases on water and mineral resources across the territory.

As established in Section 26, the assets of the States are, inter alias, surface and groundwater, and flowing, emerging and reservoir water, with the latter being restricted, as per the law, to water emerging from national works.

Section 225, sets forth that everybody is entitled to an ecologically balanced environment, which is an asset shared by all the nation's inhabitants and is a key to healthy living. As a result, both the Government and the community must protect it and preserve it for both present and future generations.

The *Secretaría de Recursos Hídricos* (Secretariat of Water Resources), which reports to the *Ministério do Medio Ambiente*, MMA (Ministry of Environment), is putting together a National Water Resources Plan, with broad participation by users, State agencies and society at large (Secretaria de Recursos Hídricos, 2005 b).

The states of São Paulo (Secretaria de Estado de Energia, Recursos Hidricos e Saneamento do Estado de São Paulo, 2005) and Goiás (Secretaria do Meio Ambiente e dos Recursos Hídricos do Estado de Goiás, 2005) have their own State Plans on Water Resources Management and, and a number of basins have their own specific basin plans (Secretaria de Recursos Hídricos, 2005 c).

- Paraguay

In Paraguay, the *Secretaría del Ambiente*, SEAM (Secretariat of Environment) has put together a National Environmental Policy proposal, which has been being analysed at the *Consejo Nacional Ambiental*, CONAM (National Environmental Council). Two bills have been prepared on water policy. Such a policy is built upon an Integrated Water Resources Management approach based on basins, and is grounded on participative and decentralised democracy.

The public sector has started to work with civil stakeholders, the *Asociación Paraguaya de los Recursos Hídricos* (Paraguayan Association of Water Resources), a number of NGOs and the SEAM, in order to outline the principles for a water resources management approach that will have to abide by the country's guidelines and development plans.

- Uruguay

Uruguay's Water Management Code establishes that it is the Executive's prerogative to formulate the National Water Policy, but no actions have been taken along these lines yet. However, authorities at the *Dirección Nacional de Hidrografía*, DNH (National Directorate of Hydrography), dependent on the *Ministerio de Transporte y Obras Públicas*, MTOP (Ministry of Transport and Public Works) have set forth a number of management guidelines, but this has occurred in response to specific conflicts that have arisen in recent years, chiefly in connection with crop irrigation. As regards drinking water, which is managed by *Obras Sanitarias del Estado*, OSE (State Sanitary Works), a number of surveys provide a few guidelines on management issues, but they are not reflected in either laws or regulations. This information is contained in OSE's Master Plan.

Despite the above-mentioned, there is growing conviction on the need for integrated management of water resources individually and in connection with other natural resources in a basin. At the DNH, basins have been used as management units for many years, and in accordance with the Irrigation Act, integrated management is performed on water and soil resources in crop irrigation, in association with the *Ministerio de Ganadería, Agricultura y Pesca,* MGAP (Ministry of Livestock, Agriculture and Fishing).

Uruguay lacks nationwide plans. However, surveys have been carried out with the aim of planning water resources management in some basins. Such is the case of a number of actions undertaken with Brazil to manage the Cuareim River. Another example is the Negro River basin –a significant Uruguay River affluent– for which a call for bids has been launched for the creation of a water resources management plan.

4.1. Institutions related with water resources

4.1.1. International institutions at the basin level

4.1.1.1. The system of the La Plata Basin Treaty

At the standpoint of the La Plata Basin structure, almost forty years ago, each of the five riparian countries had contrasting approaches to regional development, emerging from each country's different historical, geographical, social, and political background. Nonetheless, this did not exclude the existence of common goals. At that time the main issues were the utilisation of water slopes for hydro-electric power generation, subsidiary attention to navigation, and little concern for water quality and other topics (del Castillo Laborde, 1999).

The first meeting of the Foreign Affairs Ministers of the five riparian countries was held in Buenos Aires in February, 1967. As a result of that meeting, the Ministers issued a declaration, saying “that it is a decision of our governments to carry out the joint and integral study of the La Plata Basin, with a view to the realisation of a programme of multinational, bilateral and national works, useful for the progress of the region” (del Castillo Laborde, 1999).

As a first step they created the *Comité Intergubernamental Coordinador de los Países de la Cuenca del Plata,* CIC (Intergovernmental Coordinating Committee of the La Plata Basin Countries), with the aim of drawing up a statute for its definitive constitution.

Further, the declaration ruled that, to achieve the objective of the integral development of the basin, that study should take into account the following subjects: facilities and assistance to navigation; establishment of new fluvial ports and the improvement to existing ones; hydroelectric studies devoted to the energy integration of the basin; installation of water services for domestic, sanitary, and industrial uses, and for irrigation; floods and erosion control, and conservation of animal and vegetal life.

During the second meeting of Ministers, held in Santa Cruz de la Sierra in May 1968, the Statute of CIC was approved and it was entrusted to draw up a treaty in order to enforce the institutionalisation of the basin. At the same time, it was agreed to carry out preliminary studies on concrete projects presented by the countries. Among the projects shared by the five countries, the following should be noted (Pochat, 1999):

- construction of a port in Bolivian territory on the Paraguay River and its connection to the railroad network (Bush port);
- future establishment and performance of the regional network of hydro-meteorological stations;
- inventory and analysis of basic information on the basin's natural resources and related subjects;
- study of problems to be solved and projects of measures to be taken (dredging, obstacle removal, signalling, buoyage, etc.) in order to allow permanent navigation and to secure its maintenance in the Paraguay, Paraná, Uruguay and La Plata rivers;
- assessment of the ichthyologic resources of the basin.

On 23 April 1969, during their first extraordinary meeting held in Brasilia, the Ministers signed the *Tratado de la Cuenca del Plata* (La Plata Basin Treaty) which, in its Article I, only paragraph, establishes:

> “The Contracting Parties agree to unite efforts with the objective of promoting the harmonious development and the physical integration of the La Plata Basin and its area with direct and considered influence.
> Single paragraph: With that purpose, they will promote within the ambit of the basin, the identification of areas of common interest and the promotion of research,

programmes and works, as well as the formulation of operative agreements or juridical instruments they consider necessary and that tend to:
(a) give facilitation and assistance as regards navigation;
(b) promote reasonable utilisation of water resources, especially by means of the regulation of watercourses and their multiple and equitable development;
(c) achieve the preservation and the improvement of animal and vegetal life; (...)
(h) promote other projects of common interest and especially those related to the inventory, assessment and development of the natural resources of the area;
(i) integral knowledge of the La Plata Basin.

The basic organisation was then constituted by the Conference of Foreign Affairs Ministers, the CIC and a Secretariat. The Conference resolutions do not have mandatory character as regards member states, but they are applicable only in reference to the functioning of the La Plata Basin bodies. Among other things, they are compulsory when approving the budget, amending statutes or incorporating new organs.

The signature of the Treaty of Asunción, in 1991, creating the *Mercado Común del Sur*, MERCOSUR/MERCOSUL (Southern Cone Common Market), called into question the continuity of the CIC. However, the Conference of Foreign Affairs Ministers of the La Plata Basin, held in Montevideo in December 2001 reaffirmed the CIC and created the office of the General Secretariat (revolving among the countries). This Conference also created a Technical Projects Unit "...under Article I of the Treaty...to revitalise the operating system of the organism, including the creation of linkages with other technical and financial institutions within the La Plata Basin" (UNEP-GEF, 2003).

4.1.1.2. Satellite organisation

The La Plata Basin Treaty is broadly comprehensive as regards its competence on plans, projects, works, and programmes in the basin's area. Nevertheless, it is not proposed as an exclusive option for riparian states, but as a framework agreement that could add special benefits to its global scheme. Accordingly, Article VI states that "The provisions of this Treaty shall not prevent the Contracting Parties from concluding specific or partial bilateral or multilateral agreements designed to achieve the general objectives of the development of the Basin".

It was in 1973 that a push toward the realisation of joint projects was begun, bi and trilaterally. Thus, on 26 April 1973, Brazil and Paraguay subscribed the treaty where *Itaipú Binacional* (Itaipú Binational) was created with the purpose of constructing Itaipú hydropower development. On 19 November 1973 Argentina and Uruguay signed the *Tratado del Río de la Plata y su Frente Marítimo* (Treaty on the La Plata River and its Maritime Front). This Treaty settled the controversial situation about the exercise of jurisdiction over that vast river waters. Apart from jurisdictional matters, the treaty deals with navigation, fishing, bed and subsoil, pollution prevention, pilotage, works, scientific research, and rescue operations, among other aspects related to the river system. It also set up two permanent commissions, the *Comisión Administradora del Río de la Plata*, CARP (Administrative Commission for the La Plata River) and the *Comisión Técnica Mixta del Frente Marítimo*, CTMFM (Joint Technical Commission for the Maritime Front) for the adjacent maritime zone and the overlapping common fishing zone.

On 3 December 1973 the *Entidad Binacional Yacyretá,* EBY (Yacyretá Binational Entity) was created by agreement between Argentina and Paraguay, with the purpose of constructing Yacyretá hydropower development.

Subsequently, on 26 February 1975, Argentina and Uruguay agreed on the establishment of a special body for their shared stretch of the Uruguay River. The regulation of water uses, namely navigation, works, pilotage, bed and subsoil resources, fishing, pollution prevention, jurisdiction, and settlement of disputes procedures are expressly dealt with. The Commission set up under this agreement, is known as *Comisión Administradora del Río Uruguay*, CARU (Administrative Commission for the Uruguay River) (del Castillo Laborde, 1999).

In 1980, Brazil and Argentina agreed upon the use of their shared stretch of the Uruguay River and decided to build the Garabí dam as a joint project.

It should be added to this system of binational commissions and entities those established before 1973: the *Comisión Técnica Mixta de Salto Grande*, CTMSG (Joint Technical Commission of Salto Grande), created by Uruguay and Argentina in 1946 to carry out a joint hydraulic project (Salto Grande); and the *Comisión Mixta Argentino-Paraguaya del Río Paraná*, COMIP (Argentinean-Paraguayan Joint Commission of the Paraná River), created in 1971 and devoted to administrate the stretch shared by both countries and the development of Corpus Christi multiple-purpose project, in 1971 (Barberis, 1988).

A repetition of the activity pattern of the 1970s can subsequently be seen in the creation of the *Comisión Mixta Uruguayo-Brasileña para el Desarrollo de la Cuenca del Río Cuareim,* CRC (Joint Uruguayan-Brazilian Commission for the Development of the Cuareim River Basin), in March 1991; the *Comision Binacional Administradora de la Cuenca Inferior del Río Pilcomayo* (Administrative Binational Commission of the Lower Basin of the Pilcomayo River), by Argentina and Paraguay, in September 1993; of the *Comisión Trinacional para el Desarrollo de la Cuenca del Río Pilcomayo* (Trinational Commission for the Development of the Pilcomayo River Basin), by Argentina, Bolivia, and Paraguay, in February 1995, and the *Comisión Binacional para el Desarrollo de la Alta Cuenca de los ríos Bermejo y Grande de Tarija,* COBINABE (Binational Commission for the Development of the Upper Basin of the Bermejo and the Grande de Tarija Rivers), by Argentina and Bolivia, in June 1995 (Pochat, 1999).

Regarding navigation in two of the main rivers, the *Comité Intergubernamental de la Hidrovía Paraguay-Paraná (Puerto de Cáceres-Puerto de Nueva Palmira),* CIH (Intergovernmental Committee for the Paraguay-Paraná Waterway, Cáceres Port-Nueva Palmira Port) was created in 1989. In this case, it is interesting to notice that the Waterway Programme was incorporated into the System of the Treaty of the La Plata Basin in October 1991, although keeping the structure of the CIH. One of the most important achievements of this Committee was to produce the *Waterway Transport Agreement*, approved by the member states in 1992 and entered into force on 13 February, 1995. The Transport Agreement, with eight Protocols, is a common navigation code for waterway users applicable to the five riparian states.

Finally, the *Fondo Financiero para el Desarrollo de la Cuenca del Plata*, FONPLATA (Financial Fund for the Development of the La Plata Basin) was created during 1976 within the framework of the Treaty to lend financial support to the activities envisioned in the Treaty.

able 4.1 includes the various bilateral, trilateral and multilateral agencies created within the La Plata Basin as a result of the above-mentioned agreements.

Table 4.1. La Plata River Basin. Bilateral, Trilateral and Multilateral Agencies

Year of creation	**Agency**	**Member countries**				
		ARG	**BOL**	**BRA**	**PAR**	**URU**
1946	*Comisión Técnica Mixta de Salto Grande*, CTM (Joint Technical Commission of Salto Grande)	X				X
1967	*Comité Intergubernamental Coordinador de los Países de la Cuenca del Plata,* CIC (Intergovernmental Coordinating Committee of the La Plata Basin Countries)	X	X	X	X	X
1971	*Comisión Mixta Argentino-Paraguaya del Río Paraná*, COMIP (Argentinean-Paraguayan Joint Commission of the Paraná River)	X			X	
1973	*Itaipú Binacional* (Itaipú Binational)			X	X	
1973	*Comisión Administradora del Río de la Plata*, CARP (Administrative Commission for the La Plata River)	X				X
1973	*Comisión Técnica Mixta del Frente Marítimo*, CTMFM (Joint Technical Committee for the Maritime Front)	X				X
1973	*Entidad Binacional Yacyretá,* EBY (Yacyretá Binational Entity)	X			X	
1975	*Comisión Administradora del Río Uruguay*, CARU (Administrative Commission for the Uruguay River)	X				X
1976	*Fondo Financiero para el Desarrollo de la Cuenca del Plata,* FONPLATA (Financial Fund for the Development of the La Plata Basin)	X	X	X	X	X
1989	*Comité Intergubernamental de la Hidrovía Paraguay-Paraná,* CIH (Intergovernmental Committee for the Paraguay-Paraná Waterway)	X	X	X	X	X
1991	*Mercado Común del Sur*, MERCOSUR/MERCOSUL (Southern Cone Common Market)	X		X	X	X
1991	*Comisión Mixta Uruguayo-Brasileña para el Desarrollo de la Cuenca del Río Cuareim,* CRC (Joint Uruguayan-Brazilian Commission for the Development of the Cuareim River Basin)			X		X
1993	*Comision Binacional Administradora de la Cuenca Inferior del Río Pilcomayo* (Administrative Binational Commission of the Lower Basin of the	X			X	

Year of creation	Agency	Member countries				
		ARG	BOL	BRA	PAR	URU
	Pilcomayo River)					
1995	*Comisión Trinacional para el Desarrollo de la Cuenca del Río Pilcomayo* (Trinational Commission for the Development of the Pilcomayo River Basin)	X	X		X	
1995	*Comisión Binacional para el Desarrollo de la Alta Cuenca de los ríos Bermejo y Grande de Tarija,* COBINABE (Binational Commission for the Development of the Upper Basin of the Bermejo and the Grande de Tarija Rivers)	X	X			

4.1.1.3. International Projects

a) *Implementação de Prácticas de Gerenciamiento Integrado de Bacia Hidrográfica para o Pantanal e bacia do Alto Paraguai* (Integrated Basin Management Practices for the Pantanal and Upper Paraguay River Basin Project): Also know as *Upper Paraguay Project*, is being developed with resources from GEF (Global Environment Facility), with the participation of the *Agência Nacional de Águas* ANA (National Water Agency), UNEP (United Nations Environment Programme), OAS (Organization of American States), states of Mato Grosso and Mato Grosso do Sul, as well as several other organisations. Its objective is to promote sustainable development at the Upper Paraguay Basin, -which includes the Pantanal of Mato Grosso-, supporting priorities identified in the Upper Paraguay Basin Conservation Plan (PCBAP), and promoting a Strategic Action Programme (SAP), that will contemplate the main investments within the basin (ANA-GEF-UNEP-OAS, 2005).

The project has six components: 1) water quality, 2) Pantanal conservation, 3) soil degradation, 4) concerned people involvement and sustainable development, 5) organisational structure development and 6) integrated management programme implementation. The second project (Pantanal conservation), deals with inter-related themes that refer specifically to the protection and conservation of fauna and flora. Among them, there is the creation of Conservation Units in the Pantanal, as a way of preserving the natural habitats in this region, as recommended by the PCBAP (ANA-GEF-UNEP-OAS, 2005).

b) *Programa Marco para la Gestión Sostenible de los Recursos Hídricos de la Cuenca del Plata en relación con los Efectos Hidrológicos de la Variabilidad y el Cambio Climático* (A Framework for the Sustainable Management of the Water Resources of the La Plata Basin, with respect to the Hydrological Effects of Climatic Variability and Change): The Framework Programme, is funded by the Global Environment Facility (GEF), with the United Nations Environment Programme (UNEP) as the Implementation Agency and the Organization of American States (OAS) as the Executing Agency. This programme, designed to facilitate the institutional development of the CIC and the national water resources management agencies, and foster public participation, transboundary diagnosis, strategic plans, and climate change measures, among other things, has concluded its preparation phase in 2006 and will progress towards two five-year-long execution phases.

c) *Programa Estratégico de Acción para la Cuenca Binacional del Río Bermejo, PEA* (Strategic Action Programme for the Binational Basin of the Bermejo River): funded by the Global Environment Facility (GEF), with the United Nations Environment Programme (UNEP) as the Implementation Agency and the Organization of American States (OAS) as the Executing Agency. It was in its execution phase at 2005. The COBINABE is the agency in charge and the objective is to promote sustainable development in the Bermejo River Basin. The main components are:

- small and medium-sized projects designed to respond to urgent regional needs as regards water resources protection and development;
- non-structural actions designed to aid in environmental protection and environmental damage prevention, sustainable management of natural resources, institutional development and public awareness-raising and involvement;
- research activities and surveys identified as necessary for the sustainable management of natural resources.

The long-term binational PEA includes 136 pre-selected projects and an estimated budget of USD 470 million (USD 126,129,000 of which will be invested in Bolivia). The execution schedule is 20 years.

d) *Proyecto para la Protección Ambiental y Desarrollo Sostenible del Sistema Acuífero Guaraní* (Project for the Environmental Protection and Sustainable Development of the Guaraní Aquifer System): funded by the Global Environment Facility (GEF), with the World Bank (WB) as the Implementation Agency and the Organization of American States (OAS) as the Executing Agency. It provides for surveys that might enable defining the physical features of this aquifer. In addition, it plans to develop legal and institutional mechanisms for the proper management of this critical transboundary aquifer, as well as local pilot management projects with broad academic and social participation in the four countries involved (Argentina, Brazil, Paraguay and Uruguay). It will remain in its execution phase until 2006.

e) *Proyecto de Gestión Integrada y Plan Maestro de la Cuenca del Río Pilcomayo* (Integrated Management Project and Master Plan for the Pilcomayo River Basin): funded by the European Union, through a non-reimbursable loan of 12.6 million Euros and by contributions of Argentina, Bolivia and Paraguay of 8 million Euros. The project started in July 22, 2002 and has a 6 years length. Its general objective is enhancing the quality of living for the inhabitants of the Pilcomayo Basin and its environment, using a strengthened regional integration process as a basis. The specific objectives are:

- to enhance knowledge on the hydrological and environmental features of the basin, and to define the conditions required to make a rational use of water and soil resources in the basin;
- to carry out and validate actions to stabilise erosion, reduce sedimentation and mitigate the impacts of river's processes on the basin's inhabitants, among other activities; and
- to implement actions to ensure project sustainability.

4.1.2. National institutions by country

4.1.2.1. Argentina[14]

The *Subsecretaría de Recursos Hídricos de la Nación,* SSRH (National Undersecretariat of Water Resources) is the national authority on water resources management, and reports to the *Secretaría de Obras Públicas de la Nación,* SOP (National Secretariat of Public Works) of the *Ministerio de Planificación Federal, Inversión Pública y Servicios,* MINPLAN (Ministry of Federal Planning, Public Investment and Services). Its objectives are, inter alias, to assist the Secretariat of Public Works in such things as formulating and pursuing national water policies; proposing the regulatory framework on water resources management, coordinating the actions of other jurisdictions and agencies involved in water policies; developing and following programmes and actions connected with shared international water resources, their relevant basins and successive and contiguous watercourses, as well as inter-provincial hydrological basins; formulating and carrying out infrastructure management and development programmes and actions; and pursuing the national policies on the delivery of public services, drinking water and basic sanitation.

The *Secretaría de Ambiente y Desarrollo Sustentable*, SAyDS (Secretariat of Environment and Sustainable Development) is the national authority with regard to the preservation and protection of the environment, the implementation of sustainable development, and the rational utilisation and conservation of both renewable and non-renewable natural resources. All these endeavours are targeted on achieving a healthy and balanced environment suitable for human development.

Other national agencies also have jurisdiction over water resources management. The *Ministerio del Interior* (Ministry of Internal Affairs) represents the National Government in agencies in charge of interjurisdictional basins, and is involved in finding solutions to conflicts of management in connection with inter-provincial water resources. The *Ministerio de Relaciones Exteriores, Comercio Internacional y Culto*, MRECIC (Ministry of Foreign Affairs, International Trade and Cult) has jurisdiction over issues involving water resources shared with neighbouring countries. The *Secretaría de Agricultura, Ganadería, Pesca y Alimentos de la Nación,* SAGPyA (National Secretariat of Agriculture, Livestock, Fishing and Food), which reports to the *Ministerio de Economía y Producción*, MECON (Ministry of Finance and Production) oversees the conduction of programmes for rehabilitation of irrigation areas and programmes for restoration of flooded or salinised areas. This Ministry also includes the *Secretaría de Energía de la Nación* (National Secretariat of Energy), which develops basic outlines for hydropower development in basins, and coordinates compatibilities and priority uses with other areas.

The *Secretaría de Transporte de la Nación* (National Secretariat of Transport), which contains the *Subsecretaría de Puertos y Vías Navegables de la Nación* (National Undersecretariat of Ports and Waterways), is part of the MINPLAN. The *Administración de Parques Nacionales*, APN (National Parks Administration) –in charge of planning and execution activities in connection with biological and cultural diversity in the protected areas under its jurisdiction– is part of the *Secretaría de Turismo de la Nación* (National Secretariat of Tourism). The *Ministerio de Defensa de la Nación* (National Ministry of Defence) contains the *Servicio Meteorológico Nacional*, SMN (National Weather Service) and the *Servicio de*

[14] The diagnosis for Argentina was based on information provided by the Oficina Nacional de Tecnologías Informáticas, 2005 and Subsecretaría de la Gestión Pública, 2005.

Hidrografía Naval, SHN (Naval Hydrography Service). The *Consejo Nacional de Investigaciones Científicas y Técnicas*, CONICET (National Council of Scientific and Technical Research) reports to the *Ministerio de Educación, Ciencia y Tecnología*, MECyT (Ministry of Education, Science and Technology), and boasts several centres devoted to water-related topics.

Above and beyond their differing degrees of institutional development, the provincial jurisdictions -the original owners of the natural resources located in their territories- are gathered in the *Consejo Federal del Medio Ambiente,* COFEMA (Federal Council of Environment) and the COHIFE. Both institutions are used as forums of consensus and coordination between the National Government, the provinces and the Autonomous City of Buenos Aires.

Water resources management in the provinces has differing characteristics depending on the local stakeholders and the conflicts arising from water supply and demand. Irrigation management in the most arid regions and the negative effects of climate cycles –particularly floods– in humid areas, are significant drivers.

Water supply and sanitation –two needs shared across all regions– have been significant drivers for a number of independent organisations; this trend has intensified with the transfer of utilities to the private sector and the creation of Regulatory Agencies. In spite the institutional situation in the provinces is diverse, there are some shared features. Firstly, institutions have proliferated, which has led to overlapped missions and roles, frequently involving more than two agencies dependent on different Ministries or Secretariats. As from 1993, when the agencies in the sector started to be privatised, the institutional fabric increased both in size and complexity as a result of the emergence of private operators and regulatory agencies.

In the municipal arena, water resources management organisation and capacity vary considerably depending on provincial legislation, financial standing and the category of each municipality. In most cases, with the exception of the major urban centres, capacities are seriously limited.

4.1.2.2. Bolivia

The institutions included in Table 4.2 have been identified as involved in one or more stages of the water resources management process.

Table 4.2. Republic of Bolivia. Institution involved in water resources management process

Area	Institution	Role
Water Resources	*Ministerio de Desarrollo Sostenible y Planificación*, MDSP (Ministry of Sustainable Development and Planning)	Policy-setting
	Viceministerio de Recursos Naturales y Medio Ambiente (Viceministry of Natural Resources and Environment)	Policy-setting
	Dirección General de Clasificación de Tierras y Cuencas, DGCTC (General Directorate of Basin and Land Classification)	Policy-setting

Area	Institution	Role
Water Resources	*Servicio Nacional de Meteorología e Hidrología*, SNMH (National Weather and Hydrology Service)	Informational
Water Resources	*Autoridad Binacional del Lago Titicaca* (Binational Authority of Titicaca Lake)	Managerial
	Comisión Nacional de los Ríos Pilcomayo y Bermejo (National Commission for the Pilcomayo and Bermejo Rivers)	Managerial
Environment	*Ministerio de Desarrollo Sostenible y Planificación,* MDSP (Ministry of Sustainable Development and Planning)	Policy-setting
	Dirección General de Biodiversidad (General Directorate of Biodiversity)	Policy-setting
	Superintendencia de Recursos Naturales (Superintendence of Natural Resources)	
	Servicio Nacional de Áreas Protegidas (National Service of Protected Areas)	Managerial
Drinking Water	*Ministerio de Vivienda y Servicios Básicos,* MVSB (Ministry of Housing and Basic Services)	Policy-setting
	Superintendencia de Servicios Básicos (Superintendence of Basic Services)	Regulatory
	Utilities Companies	Managerial
Power	*Ministerio de Energía* (Ministry of Energy)	Policy-setting
	Superintendencia de Electricidad (Superintendence of Electric Power)	Regulatory
	Generators and Distributors	Managerial
Irrigation	*Ministerio de Agricultura, Ganadería y Desarrollo Rural,* MAGDR (Ministry of Agriculture, Livestock and Rural Development)	Policy-setting
	Programa Nacional de Riego y Drenaje (National Programme of Irrigation and Drainage)	Policy-setting

According to the Organic Act of the Executive Branch, the following Ministries and Agencies have formal competence on water resources (ADSIB, 2005):

- The *Ministerio de Desarrollo Sostenible y Planificación,* MDSP (Ministry of Sustainable Development and Planning), in charge of formulating strategic plans for sustainable development and territorial management on a national, regional and municipal basis; promoting sustainable development in the country by articulating economic, social and technological development with the environmental conservation and biodiversity; preserving, conserving and restoring renewable natural resources; and overseeing the *Sistema de Regulación de Recursos Naturales Renovables*, SIRENARE (Regulatory System on Renewable Natural Resources).

- The *Dirección General de Clasificación de Tierras y Cuencas,* DGCTC (General Directorate of Basin and Land Classification) of the MDSP is the agency responsible for formulating the National Basin Management Plan.

- The *Ministerio de Agricultura, Ganadería y Desarrollo Rural*, MAGDR (Ministry of Agriculture, Livestock and Rural Development) is in charge of formulating, pursuing and controlling policies and regulations on agriculture and livestock developments, and managing renewable natural resources in terms of their general development.

- The *Ministerio de Vivienda y Servicios Básicos*, MVSB (Ministry of Housing and Basic Services) is responsible for drinking water and sanitation.

These Ministries are broken down into General Administrations through the Departmental Offices. As well, both the Act on Community Participation and the Municipalities Act establish that each Municipal Government is responsible for environmental and natural resources management in its jurisdiction (ADSIB, 2005).

In 1994, the *Sistema de Regulación Sectorial*, SIRESE (Sectorial Regulation System) was created with the goal of regulating, controlling and overseeing public service delivery and economic activities within the private sector. Later, this model was expanded to natural resources with the creation of the SIRENARE, which is valid for two resource types –land and forestry–, but is not applicable to water (ADSIB, 2005).

On April 20, 2002 and thanks to the encouragement offered by the *Comité Nacional para la Gestión Integral del Agua en Bolivia*, CGIAB (National Committee for Integrated Water Management in Bolivia) and the Ministry of Agriculture, the Bolivian Government enacted an Executive Order whereby the *Consejo Interjurisdiccional del Agua*, CONIAG (Interjurisdictional Water Council) was created. The purpose of this institution was to enable discussion and consensus between the State and social organisations with a view to building the legal, institutional and technical framework required for formalising and regulating water resources management (ADSIB, 2005).

The CONIAG is comprised of the Ministries of Sustainable Development and Planning, Agriculture, Livestock and Rural Development, Financial Development and Housing and Basic Services; one representative from the national government validated by the Municipalities; and five representatives from civil society (farmers, members of First Nations, irrigators, private corporations and relevant academic and research institutions).

The CONIAG's mandate lasts for three years and is funded by international cooperation agencies. Operational activities are performed by a Technical Secretariat. The CONIAG might become an example of citizen participation in the consensus-based creation of an Act on Water Resources in the country. This agency shall define –through broad consultation and debate mechanisms– a document on Bolivia's National Water Resources Policy, which will in turn be followed by an Act on Water (ADSIB, 2005).

At basin level, the *Comisión Nacional de los Ríos Pilcomayo y Bermejo* (National Commission for the Pilcomayo and Bermejo Rivers) was created in February 1989, with the aim of agreeing on international negotiation policies in connection with the development of both basins and the use of their multiple resources, and with the purpose of acting as a counterpart in the negotiation process.

The technical and operational agency of this Commission is the *Oficina Técnica Nacional de los Ríos Pilcomayo y Bermejo*, OTNPB (National Technical Office for the Pilcomayo and Bermejo Rivers). It is responsible, inter alias, for promoting the sustainable development of the basins, and is designed to act as a technical counterpart in international agreements.

4.1.2.3. Brazil

The intention of reforming the Brazilian water resources management system began to take shape during the 1980s, when technical sectors of the government recognised that the time had come to modernise the sector, which had been functioning until then based on the 1934 Water Code. Although the Water Code was a major legal landmark in the country, and enabled the remarkable expansion of the Brazilian hydroelectric power system, it was never fully implemented. Actions had been exclusively sectorial, and had never been regulated, as was the case of the articles that referred to multiple use and water quality conservation (Praciano Minervino, 2002).

At the beginning of the 1980s, the technical sectors of the government in the *Ministério de Minas e Energia* (Ministry of Mines and Energy), helped to include among the guidelines of the 3rd. National Development Plan, for the period 1980-1985, that: “the Government should sponsor the establishment of a National Water Resources Policy” (Praciano Minervino, 2002).

In 1983, an International Seminar on Water Resources Management was held in Brasilia, whose conclusions had an important effect by triggering a debate on water resources management at national level, with meetings being held in six Brazilian State’s capitals.

These actions had their origin in the good results obtained from the 1976 agreement between the Ministry of Mines and Energy and the Government of São Paulo State, to improve sanitary conditions in the Upper Tietê and Cubatão rivers basins. As a result of the lessons learned, the *Comitê Especial de Estudos Integrados de Bacias Hidrográficas,* CEEIBH (Special Committee for Integrated Studies on River Basins) was set up in 1978, and took on the task of establishing executive committees in several federal basin, among them the Paraíba do Sul and São Francisco committees. These committees had been assigned only consultative tasks, making it difficult to implement their decisions. Even so, these were fundamental experiences in the history of water resources management in Brazil.

In 1986, the Ministry of Mines and Energy created a Working Group, made up of state and federal agencies, to study and propose the organisation of a water resources management system. The final report recommended the creation of a national system, and that State’s territories and the Federal District were informed of the need to institute similar systems.

São Paulo State, which had been involved in restructuring the sector since 1983, and sharing the same concerns, began in 1986 to discuss the need to look at water resources from multiple aspects, causing an institutional and technical debate, so that a feasible system could be created from a technical standpoint and, at the same time, be practicable from a political standpoint. The message was that this subject had to expand beyond the technocratic spheres of government to include other interested segments of society.

The debate thus began to expand. The need to bring together social and technical sectors of the government, and take this discussion to the political arena, was recognised. The resulting participation made 1987 a landmark year in the modernisation of the water resources sector. Ten years after the Mar del Plata Conference, Brazil had begun to put one of its fundamental recommendations into practice, i.e., open debate on the participatory management of water resources (Praciano Minervino, 2002).

In that same year, the *Associação Brasileira de Recursos Hídricos,* ABRH (Brazilian Association of Water Resources) made its statement in the Salvador Letter, drawn up during the 7th Brazilian Water Resources Symposium, regarding the pressing need for the creation of a national water resources system and the improvement of pertinent legislation, to take into account the multiple uses of water resources, decentralised and participatory management, the institution of a national system of information on water resources and technological development and training in the sector (Praciano Minervino, 2002).

Realising the importance of this topic, ABRH created the Water Resources Management Committee and began a new and extremely useful stage in which the technical community took part to expand the scope of the debates (Praciano Minervino, 2002).

Also in 1987, after intense debates held within the Government of São Paulo State, and supported by groups from the Piracicaba River Basin –who were demanding action for its recovery–, the *Conselho Estadual dos Recursos Hídricos* (State Council for Water Resources) was created, with the task of drawing up the policy for water resources in the state, designing the Integrated Water Resources Management System and preparing a plan for the state's water resources (Decree 27,576, of November 11, 1987, altered by Decree 36,787 of May 18, 1993).

At the same time, the first Inter-municipal Consortium of Santa Maria/Jucu was constituted in the Espírito Santo State, to facilitate negotiations among water resource users interested in resolving their differences (Praciano Minervino, 2002).

During the same year, Ceará State established its State Secretariat for Water Resources and began to prepare the state's Water Resources Plan, which was drawn up over the 1988-1991 period (Praciano Minervino, 2002).

Based on these initiatives, a broad discussion process began, with the participation of professionals through ABRH, together with its sister bodies, the *Associação Brasileira de Engenharia Sanitária e Ambiental*, ABES (Brazilian Association of Sanitary Engineering), *Associação Brasileira de Aguas Subterrâneas,* ABAS (Brazilian Association of Groundwater), the *Associação Brasileira de Irrigação e Drenagem,* ABID (Brazilian Association Irrigation and Drainage), and governmental sectors, in order to present proposals for the 1988 constitutional reform (Praciano Minervino, 2002).

As a result, Article 21, XIX was included in the 1988 Constitution: "The federal government is empowered to (...) set up a National Water Resources Management System, and define criteria for the granting of use's rights…". This was later reproduced in the constitutions of 12 states and of the Federal District that were enacted after 1989, and included mention of water resources management systems. From that time on, the society and the government moved to effectively implement this principle of the Constitution (Praciano Minervino, 2002).

The convergence of a number of facts allowed the rapid evolution of this sector. Local, regional and national initiatives stand out among the public and private bodies, and technical/scientific and professional associations that came together to build the institutional framework of the water resources sector in Brazil (Praciano Minervino, 2002).

Also in 1988, the Sinos and Gravataí rivers basin's committees were created. These are tributaries of the Guaiba River, in Rio Grande do Sul State, and the creation of these committees was considered a pioneering initiative, as the basin's communities themselves, with the support of the state government, worked for their creation (Praciano Minervino, 2002).

ABRH remained active and, in 1989, produced the Foz do Iguaçu Declaration, which had great repercussions among professionals. That document laid out the basic principles to be followed in determining National Water Resources Policy, such as integrated management, the basin as a management unit, recognising the economic value of water and decentralised, participatory management (Praciano Minervino, 2002).

In 1989, in another pioneering initiative, several towns within the Piracicaba and Capivari basins joined forces to form the Intermunicipal Consortium of the Piracicaba and Capivari Basins, with the idea of encouraging not only the environmental rehabilitation of the rivers, but regional integration and a development plan for both basins. This initiative consolidated a new vision among local governments, increasing the participation of civil society in the water resources decision-making process (Praciano Minervino, 2002).

Among the first effective actions to modernise the sector was the decision, by the Government of São Paulo State, to send to the state congress in 1990, a bill of law creating the state's Water Resources Policy and Water Resources Management System. This bill of law, enacted in 1991, consolidated the participation of civil society in the decision-making process, determining the implementation of water charges, and that the resulting funds are managed through the *Fundo Estadual de Recursos Hídricos*, FEHIDRO (Water Resources State Fund), to finance measures requested by the basins committees. FEHIDRO became one of the most important innovations in this sector, because it ensured that funds went directly to the water resources system, free from political interferences typical of the resources allocation process (Praciano Minervino, 2002).

Also in 1991, the Federal Government sent for approval of the National Congress a bill of law creating the National Water Resources System and defining National Water Resources Policy (Praciano Minervino, 2002).

In that same year ABRH gave out the Rio de Janeiro Letter, which showed the progress made within technical circles on water resources management and indicated the need to integrate water resources and environment systems. It also indicated the need to have a sufficiently flexible water resources management system in the country, which would provide for regional diversity (Praciano Minervino, 2002).

With regard to the process of enacting the federal bill of law, there were many obstacles to be overcome especially at federal level. The broadening of the debate, to include organised segments of society, professional associations and sector institutions, was essential to ensure the continuance of the initial principles proposed for water resources management (Praciano Minervino, 2002).

Due to the length of time it took for the federal law to be approved, the Brazilian states began to create their own water resources management systems: São Paulo in 1991, Ceará in 1992, Santa Catarina and the Federal District in 1993, Minas Gerais and Rio Grande do Sul, in 1994, and Sergipe and Bahia in 1995, all enacted water resources laws.

The Ceará law, enacted in 1992, was the second state law to come into force in Brazil, and it opened the way for that state to propose an innovation in institutional arrangements for the sector, completed when the Ceará's *Companhia de Gestão dos Recursos Hídricos,* COGERH (Water Resources Management Company) was established in 1993. The pioneering experience of COGERH, which began the process of charging for the supply of bulk water to industrial and public sectors in urban areas is worth remembering. The money collected is used to run the management system itself, and is controlled by COGERH (Praciano Minervino, 2002).

On the international scene, the movement to modernise water management in Brazil found support in the International Conference on Water and the Environment held in Dublin, in January 1992 (Praciano Minervino, 2002).

Between 1993 and 1997, 20 basin's committees were created in São Paulo State, to become water resources management units. The experience of the basin's committees in that state is considered innovative, being responsible for investing funds from FEHIDRO. During this same period, several international organisations supported Brazil in its work of modernising the sector. One that deserves special mention is the World Bank, which –through its water resources policy– supported the Ceará State's *Projeto de Desenvolvimento Urbano e Gestão de Recursos Hídricos,* PROURB (Urban Development and Water Resource Management Project), through which the institutional reform of the sector in that state was implemented with the creation of water users' associations, which were the base for future basin's committees and improvements in water infrastructure.

In subsequent years this experience was repeated in Bahia State and expanded to create the *Programa de Desnvolvimento de Recursos Hídricos para o Semi-Arido Brasileiro*, PROAGUA-Semi Arido (Semi-Arid Water Resources Development Programme) in 1998, and the *Programa Federal de Gestão de Recursos Hídricos,* PROÁGUA (Federal Water Resources Management Programme) in 2000 (Praciano Minervino, 2002).

In 1995, amidst the approval process of the federal bill of law on water resources, the *Ministério de Ambiente, Recursos Hídricos e Amazonia Legal* (Ministry of the Environment, Water Resources and Legal Amazon[15]) was created and, within this ministry, the *Secretaría de Recursos Hídricos*, SRH (Secretariat of Water Resources). In February 1996 an amendment to that bill of law was presented. This new version included a flexible river basin management model that took regional diversities into account.

While the bill went through the channels, negotiations between the states and the federal government allowed Federal Decree 1,842, of March 22, 1996 to be published, creating the Committee for the Integration of the Paraiba do Sul Basin, a different model from previous ones. The Committee was made up of 3 federal representatives and 12 representatives from each of the riparian states, i.e., São Paulo, Rio de Janeiro and Minas Gerais. Furthermore, 50% of the committee's members come from civil society and water resources users groups, and decisions are taken by a two-thirds majority of all members. With this framework and rules of procedure, the committee deliberates by consensus among the states, and the federal representatives have the important role of articulating and negotiating this consensus. Their performance in this role marked a significant movement towards the decentralisation of the entire decision-making process (Praciano Minervino, 2002).

[15] The administrative reform of the Brazilian Government in 1999 gave this Ministry a new name: *Ministerio do Meio Ambiente* (Ministry of Environment).

On January 8, 1997 Law 9,433, which defined National Water Resources Policy and created the National Water Resources Management System, was sanctioned. The nation now had a legal instrument which, when fully implemented, would ensure the availability of water in adequate conditions for future generations.

The Objectives of National Water Resources Policy are (Praciano Minervino, 2002):

- ensure the availability of water as needed, at standards of quality appropriate to the respective uses, for present and future generations;
- ensure the rational and integrated use of water resources, including waterway transportation, with a view to sustainable development; and
- prevent and protect against natural events or resulting from the integrated use of water resources.

With the enactment of that law a new era began, bringing new challenges. The time has come to end discussions about the management model, and face the challenge of implementing them (Praciano Minervino, 2002).

There are many challenges. The National Water Resources Policy –defines by Law 9,433/97–, considers water as a good in the public domain, with its economic value, and priority uses for human and livestock consumption, and whose management is based on the basin as a territorial unit. Its overall guideline is the integrated water management, and it establishes the instruments to use in implementing the National Policy: the water resources plans, the classification of bodies of water according to their main uses, the concession of water rights, water charges and the water resource information system.

The National Water Resources Management System, also created by Law 9,433, tends to achieve the following objectives:

- coordinate the integrated management of waters;
- arbitrate water use related conflicts administratively;
- implement the National Water Resources Policy;
- plan, regulate and control the use, preservation and recovery of water resources; and
- encourage charging for water use.

The National Water Resources Management System is made up of:

- the *Conselho Nacional do Recursos Hídricos*, CNRH (National Council of Water Resources);
- the water resources councils of the states and the Federal District;
- the basin committees;
- the government agencies with attributes related to water resources management; and
- the water agencies, which have one or more basins as area of action and have the planning for the basin's water resources and charging for water use as their main duties.

Another major characteristic of the system is the importance assigned to public participation. The participation of users and civil society is assured at all meetings called, from the CNRH to the basin's committees, thus legitimising decisions and also insuring their implementation.

In this sense, the states also advanced rapidly towards creating basin's committees, and Ceará State established its first basin committee in 1998, an example of how to work with user communities (Praciano Minervino, 2002).

Law 9,433 promotes a radical decentralisation of management, from the seat of public power to the local sphere of the basin. It creates an association between public power and organized civil society. Public power renounces part of the powers that can, by nature, be shared or delegated. Decision power comes to be shared in the Basin Committees and in the National or State Water Resources Councils. The law authorises the delegation of charging for water use to Water Agencies, but keeps the power to grant rights of use within public power (Praciano Minervino, 2002).

The law also seeks to guarantee system feasibility: financial feasibility, by allocating part of the resources collected by means of charging for water use to paying for the expenses of the bodies integrating the system and to financing those interventions identified by the planning process; and administrative feasibility, by creating bodies which give technical, financial and administrative support to the system's collegiate bodies (Praciano Minervino, 2002).

The implementation of the system continued with the regulation of the CNRH, implemented by Federal Decree 2,612, of June 1998. In November of the same year, under the chairmanship of the Minister of the Environment, the first Ordinary Meeting was held. The SRH of the Ministry of the Environment performs the function of Executive Secretariat to the CNRH, and provides technical, administrative and financial support to the Council. Its first task was to organise the National Water Resources Management System, especially with regard to regulating the system and establishing general criteria on how to apply the management instruments created by Law 9,433/97 (Praciano Minervino, 2002).

Among the main innovations introduced by Law 9,433/97 was the clarity in defining the mechanisms that were to be used in implementing National Water Resources Policy (Praciano Minervino, 2002):

- the Water Resources Plans;
- classification of bodies of water according to main uses;
- concession of water rights;
- charging for water resource use;
- compensation to municipalities; and
- the Water Resources Information System.

Law 9,433/97 is modern and important for the territorial organisation of the country, but it means major changes for public administrators and users, since it requires the acceptance of the principles of constituting partnerships (Praciano Minervino, 2002).

In this sense, the main difficulty experienced in the years subsequent to the approval of Law 9,433/97 was in the institutional arrangement for the Water Resources Management System and the lack of an agency responsible for implementing National Water Resources Policy. A system, based almost exclusively on the action of basin committees, would not have the framework necessary to fulfil essential technical activities such as the concession of water rights, or even to implement complex systems such as water charges (Praciano Minervino, 2002).

Law 9,433/97 lacked the regulations to be effective. At that time it was identified the fact that the National Water Resources Management System was an institutionally advanced and complex one, especially because it was integrated, decentralised and participatory, while local government administrations and agencies faced with the demands generated by new economic, social and political circumstances were in a state of crisis. In this sense it was remarked that the recent institution of federal agencies to regulate public services in the process of being privatised indicated a technically and legally feasible option for the institutional organisation of the water resources sector (Praciano Minervino, 2002).

Based on this possibility, the subject was discussed at different levels of the Federal Government and, in April 1999, the President of Brazil announced his intention to establish a government agency, under a special regime, to be responsible for developing the National Water Resources Management System.

This agency would have sufficient autonomy, stability and flexibility to overcome the difficulties involved in implementing the Water Resources Management System. In July of the same year, a seminar was organised at the Presidential Palace, on the subject of: “Water, the Challenge for the Next Millennium”, with the presence of the President of Brazil, the Vice-President and 10 Cabinet Ministers, for the presentation of the new institutional arrangement for the water resources sector, which included the creation of the *Agência Nacional das Aguas,* ANA (National Water Agency).

The bill of law creating the ANA was approved by the Brazilian Congress on June 20, 2000, becoming Law 9,984 which was sanctioned by the Acting President of Brazil on July 17 of that year.

The ANA is subordinated to the *Ministério do Meio Ambiente,* MMA (Ministry of Environment), but has administrative and financial autonomy. It is responsible the regulatory discipline of activities on the rivers, of sources of pollution and waste, in order to ensure that water will be available for future generations. In carrying out this work, the ANA will follow the principles, guidelines and instruments of National Water Resources Policy, and coordinate with the public and private agencies that make up the National Water Resources Management System.

When Decree 3,692 of December 19, 2000 was published, the Agency was installed, and its Board of Directors, whose names were approved by the Federal Senate, took office on December 22 of that same year.

- Institutions in the National Setting

Law 9,433/97, on administrative organisation for the water resources sector, created some new institutions for promoting the use of management instruments. It is important to emphasise the CNRH, the basin committees and the water agencies as brand new organisations that are now a part of the National Water Resources System (Praciano Minervino, 2002)..

The CNRH is a collegiate body, made up of representatives of the ministries and departments of the Presidency of the Republic, acting in the management of the use of water resources; representatives indicated by the State water resources councils; representatives of the users, and representatives of the water resources civil organisations (Praciano Minervino, 2002).

Generally speaking, the jurisdiction of the CNRH includes formulating the national policy on water resources, administratively arbitrating conflicts within the sector, assessing proposals for changing the relevant laws, instituting new basin committees, accompanying the creation of the national water resources plan, as well as establishing general criteria as regards granting rights of use and charging for the use of water resources.

Among water resources civil organisations, basin intermunicipal associations and consortiums; regional, local or sectorial associations of water resources users; technical, education and research organisations with interests in the water resources area; and non-governmental organisations aiming at safeguarding diffuse and collective interests of society were defined (Praciano Minervino, 2002).

The SRH plays the role of Executive Secretariat of the CNRH. It is within the Executive Secretariat's jurisdiction to lend administrative, technical and financial support to the CNRH, to coordinate the elaboration of the National Water Resources Plan and to submit it for CNRH approval and to coordinate the National Information System on Water Resources (Praciano Minervino, 2002).

The Council has widened its participation base by creating eight Technical Chambers, allowing for the involvement of over 100 highly qualified professionals from various sectors of society. The Technical Chambers are: Groundwaters, Project Analysis, Legal and Institutional Matters, Science and Technology, Charging for the Use of Water Resources, Transboundary Water Resources Management, Integration of Procedures, Granting Actions and Regulatory Actions, and National Water Resources Plan (Praciano Minervino, 2002).

4.1.2.4. Paraguay

The *Secretaría del Ambiente*, SEAM (Secretariat of Environment), created by National Law 1,561/00, aims to formulate, coordinate, execute and supervise the national environmental policy. With respect to water resources, its structure encompasses the *Dirección General de Protección y Conservación de los Recursos Hídricos,* DGPyCRH (General Directorate of Water Resources Protection and Conservation), an agency with the status of State Undersecretariat, the maximum authority within the water sector (Gamarra Lovera, 2002).

The DGPyCRH's function is to "formulate, coordinate and assess the maintenance and conservation policies for water resources and their basins, guaranteeing the renewal process, the maintenance of basic watercourse flows, the capacity of aquifer recharge, the protection of the various uses and the exploitation of water resources, preserving the ecological balance" (Gamarra Lovera, 2002).

The SEAM draws together all the other institutions associated with water resources, in order to draft the National Water Resources Management Policy. The interinstitutional relation still needs to be regulated through the *Sistema Nacional Ambiental,* SISNAM (National Environmental System), also created by Law 1,561/00, and the water law still needs to be passed, on the basis of the Water Resources Management Policy proposed by SEAM (Gamarra Lovera, 2002).

There are also other institutions that carry out water resources management tasks, such as (Gamarra Lovera, 2002):

- The *Ente Regulador de Servicios Sanitarios del Paraguay,* ERSSAN (Sanitary Services Regulatory Agency of Paraguay) is an autarchic entity, with legal status, hierarchically depending on the Executive Power. Its powers and obligations include regulating the provision of the service, supervising its efficiency and quality standard and protecting the interests of the community and the users.

- The *Servicio Nacional de Saneamiento Ambiental,* SENASA (National Environmental Sanitation Service), a technical agency of the *Ministerio de Salud Pública y Bienestar Social* (Ministry of Public Health and Social Welfare), is mainly devoted to planning and promoting environmental sanitation activities. The SENASA is authorised to promote and carry out works, and to provide organisational, administrative and technical assistance for the provision of the service in both urban and rural populations with a number equal to/or less than 10,000 inhabitants.

- The *Empresa de Servicios Sanitarios del Paraguay*, ESSAP (Sanitary Service Company of Paraguay), created on 4 March 2002, is a corporation originating from a state institution (CORPOSANA), which, after serving for 48 years in the drinking water sector, moved to the private sector. This new company will have 99-year duration and its aim is the provision of drinking water and sewerage services, including water collection and treatment.

The technical and economic feasibility of exploiting aquifers as public supply sources has led to the emergence of private distributors of drinking water services (called “aguaterías”), which in turn has given rise to a significant market: the tubular well drilling industry. The water private sector has evolved mainly from water truck drivers, who, one generation ago, carried water to those neighbourhoods that were not served by public enterprises. These water truck drivers got together into an association of private water suppliers called *Cámara Paraguaya del Agua,* CAPA (Paraguayan Water Chamber), and became companies with their own artesian wells and water-pipe networks, financing their investments and setting their prices. They are currently regulated by the ERSSAN.

- The *Dirección de Meteorología e Hidrología,* DMH (Directorate of Meteorology and Hydrology), of the *Dirección Nacional de Aeronáutica Civil* (National Directorate of Civil Aeronautics), depending on the *Ministerio de Defensa Nacional* (Ministry of National Defence), has the largest number of meteorological stations administered at the national level.

- The *Ministerio de Obras Públicas y Comunicaciones,* MOPC (Ministry of Public Works and Communications) has a *Centro Multiuso de Monitoreo Ambiental,* CMMAH (Multi-Use Environmental Monitoring Centre) with an automated monitoring network, in charge of managing and controlling hydrological and agro-meteorological data, with 7 monitoring stations in the Upper Paraguay region.

- The *Administración Nacional de Navegación y Puertos,* ANNP (National Administration of Navigation and Ports), depending on the MOPC, is an autarchic entity in charge of monitoring surface water resources networks. It provides a large amount of information on water levels.

The SEAM shares the topics of “Water and Health” with the Ministry of Public Health and Social Welfare; “Water and Transport” with the ANNP; “Water and Energy” with the *Viceministerio de Minas y Energía* (Viceministry of Mines and Energy); “Water and Food” with the *Ministerio de Agricultura y Ganadería,* MAG (Ministry of Agriculture and

Livestock); “Water and Industrial Development” with the *Ministerio de Industria y Comercio*, MIC (Ministry of Industry and Trade); “Water and Resource Planning” with the *Secretaría Técnica de Planificación* (Secretariat of Technical Planning); and “Variability and Climate Change” and “Water and Disasters” with the DMH.

4.2.1.5. Uruguay

The Uruguayan state is unitary and decentralised. This means that, in addition to the central government, each department has government bodies acting with financial and administrative autonomy. The territory is divided into 19 departments, each with an executive body, the *Intendencia Municipal* (Municipal Intendancy) and a legislative body, the *Junta Departamental* (Departmental Board). In cities outside the capital of the department there may be Local Councils. The members of the first two institutions are elected directly in each department, and hold office for 5 years. The *Intendente Municipal* (Mayor) can only be re-elected once. The members of the Local Councils are appointed by the Mayor, with the agreement of the Departmental Board (von Cappeln, 2002).

The *Ministerio de Transporte y Obras Públicas,* MTOP (Ministry of Transport and Public Works) is in charge of supervising, monitoring and regulating those activities and works related to water study, catchment, use, conservation and disposal, regardless of use and purpose, as well as deciding on the suspension or elimination of contravening works. Also, it is in charge of the country’s water resources inventory and the Water Public Registry, where exploitation rights are registered (von Cappeln, 2002).

In 1990, the *Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente,* MVOTMA (Ministry of Housing, Territorial Planning and Environment) was delegated with the power to control the quality of the resource, consisting in protecting water against deleterious effects and damage to the environment. A prior environmental authorisation is required to grant water exploitation rights, depending on the activity or the kind or hydraulic development to be built. The MVOTMA also grants effluent discharge permissions, sharing jurisdictions with the Departmental Governments, as well as with *Obras Sanitarias del Estado,* OSE (State Sanitary Works) as regards watercourses intended for human supply (von Cappeln, 2002).

The *Ministerio de Ganadería, Agricultura y Pesca*, MGAP (Ministry of Livestock, Agriculture and Fishing) is in charge of approving the Soil and Irrigation Water Use and Management Plan; this duty is fulfilled through the *Dirección General de Recursos Naturales Renovables,* DGRNR (General Directorate of Renewable Natural Resources).

The MTOP duties mentioned above are carried out through the *Dirección Nacional de Hidrografía,* DNH (National Directorate of Hydrography), a decentralised body created by law of 1911, which administrates water resources independently from the various user sectors. The DNH is an Executing Unit with a high degree of technical and functional autonomy, since, by the MTOP’s decision, it was delegated with those jurisdictions associated with the management of water exploitation rights (von Cappeln, 2002).

Regarding water resources management, it is the DNH’s duty to make regulatory proposals for the correct use and sustainable development of water; to grant water exploitation rights and approve the relevant hydraulic developments; to control compliance with regulations in force and imposed conditions; to propose the application of sanctions; to arbitrate settlements between users; to register the rights in the Water Public Registry; to carry out studies –mainly planning ones– and to perform the water resources inventory; to administrate the extraction of materials from riverbeds and water bodies by means of granting permissions and overseeing inspectors; and to carry out actions for protection against floods (von Cappeln, 2002).

The MVOTMA's aims with respect to the environment are fulfilled through the *Dirección Nacional de Medio Ambiente,* DINAMA (National Directorate of Environment), which is responsible for formulating, executing, supervising and assessing the national plans for the protection of the environment, as well as for proposing and implementing the national policy on the matter while conjugating environment protection needs and sustainable development. As regards water resources conservation and management, it is in charge of executing, supervising and assessing plans for measuring and evaluating the status of water resources quality; plans to prevent environmental impact from human activities or projects, including fostering environmental awareness; plans to control public and private activities that might affect the quality of water resources; formulating and coordinating actions with national and departmental public bodies with respect to the protection of the environment, as well as making agreements with public and private, national and foreign agents, for achieving its aims (von Cappeln, 2002).

The *Oficina de Planeamiento y Presupuesto,* OPP (Office of Planning and Budget), depending directly on the Presidency of the Republic, sets the public investment and borrowing policies in the sector. It also acts as a Control Unit for some loans by international financial institutions, intended for investments in the sector (von Cappeln, 2002).

OSE is a decentralised service that connects with the Executive Power through the MVOTMA. This means that the Executive Power cannot direct it to adopt any resolutions, although it can control the relevance and legality of its acting. OSE is in charge of providing the public service of supplying drinking water throughout the country, and of sanitation in the whole territory, except for the city of Montevideo, where this corresponds to the Departmental Government (von Cappeln, 2002).

The *Administración Nacional de Usinas y Trasmisiones Eléctricas,* UTE (National Administration of Power Stations and Electric Transmissions) is an industrial and commercial autonomous entity in charge of providing the electricity public service, encompassing electric power generation, transmission, transformation, distribution and commercialisation. This agency manages all hydroelectric generation units in the country, with the exception of the binational Salto Grande dam (Argentina and Uruguay), located on the Uruguay River (von Cappeln, 2002).

In the *Ministerio de Industria, Minería y Energía,* MIEM (Ministry of Industry, Mining and Energy), the *Dirección Nacional de Minería y Geología,* DINAMIGE (National Directorate of Mining and Geology) carries out groundwater drilling and studies, in addition to hydro-geological resources studies and localisation (von Cappeln, 2002).

The *Universidad de la República,* UDELAR (University of the Republic) performs diverse water-related studies, generally through agreements with several state bodies (von Cappeln, 2002).

- *Interinstitutional bodies*

The *Programa para el Manejo de Recursos Naturales y Desarrollo del Riego,* PRENADER (Natural Resources Management and Irrigation Development Programme), consisting of representatives of the MGAP, MTOP, OPP and those rural farmers aided by the World Bank, fostered the expansion of irrigation by carrying out private works and promoting user associations over the 1996-2001 period (von Cappeln, 2002).

- *Private Operating Firms*

Their activity as drinking water or sewerage service providers in the sector is recent and limited to two OSE franchisees and a few water networks to supply housing subdivisions in the beach resort area and isolated villages in the Maldonado Department, mainly devoted to tourism (von Cappeln, 2002).

As regards private operating firms in drinking water and sewerage services, the constitutional reform approved by the citizenship on October 31 will undoubtedly force changes (von Cappeln, 2002).

4.1.3. Local

4.1.3.1. Argentina

The provincial jurisdictions –holders of the original ownership of their natural resources– have created, with various degrees of institutional development, the COHIFE and the COFEMA for agreement and coordination between the Nation, the provinces and the Government of Buenos Aires City (Oficina Nacional de Tecnologías Informáticas, 2005).

Water resources management in the provinces takes on different features depending on the main local interests and conflicts arising from water supply and demand. The management of irrigation in the arid region and of the deleterious effects of climate cycles, particularly floods, in the humid region are relevant axes (Oficina Nacional de Tecnologías Informáticas, 2005).

Water supply and sanitation, a common need to all regions, has guided differentiated and independent organisations, an aspect that has increased with the transfer of services to the private sector and the creation of Regulatory Bodies (Oficina Nacional de Tecnologías Informáticas, 2005).

The *Secretaría de Estado de Recursos Hídricos de la Nación*[16] (National State Secretariat of Water Resources), created in December 1969, signed an agreement with the provinces of Catamarca, Jujuy, Salta, Santiago del Estero and Tucumán on 02/18/1971 on the creation of Basin Committees for hydrographic units existing in their territories. These Committees had the status of coordination and planning bodies (Oficina Nacional de Tecnologías Informáticas, 2005).

The agreement was ratified by national and provincial laws. Seven Basin Committees were later created. These worked operatively until 1989, when, by common agreement of the

[16] This Secretariat was later replaced by the current *Subsecretaría de Recursos Hídricos de la Nación* (National Undersecretariat of Water Resources)

Nation and the provinces involved, the activities were cancelled as a consequence of the State Reform at the national level (Oficina Nacional de Tecnologías Informáticas, 2005).

At the beginning of 2000s, some of said bodies have been restored, with an active participation of both the provinces and the Nation, which is taking on a fostering role, facilitating inter-provincial relationships. Within the La Plata Basin, it is important to mention the Basin Committee of the Pasaje-Juramento-Salado Rivers. Furthermore, at various times, other interjurisdictional bodies have been created, such as the *Comisión Regional del Bermejo,* COREBE (Regional Commission of the Bermejo River), the *Comisión Interjurisdiccional de la Laguna La Picasa* (Interjurisdictional Commission of La Picasa Lagoon), the *Comisión Interjurisdiccional de la Región Hídrica de la Llanura Pampeana* (Interjurisdictional Commission of the Pampean Plain Water Region). Also, there is a project for the *Comité de Cuenca de los Bajos Submeridionales* (Sub-Meridional Lowlands Basin Committee).

Given Argentina's federal structure, each province and the City of Buenos Aires have their own water resources management bodies. Table 4.3 shows the bodies corresponding to the jurisdictions within the La Plata Basin.

Table 4.3. Argentina. Management institutions on water resources by province

Jurisdiction	Management body	E-mail	Website
City of Buenos Aires	*Secretaría de Obras y Servicios Públicos* (Secretary of Public Works and Utilities)	---	http://www.buenosaires.gov.ar/areas/obr_publicas
Buenos Aires	*Autoridad del Agua* (Water Authority)	correoada@yahoo.com.ar	---
Catamarca	*Secretaría de Estado del Ambiente* (State Secretariat of Environment)	sucytca@seambiente.gov.ar	http://www.seambiente.gov.ar
Chaco	*Administración Provincial del Agua* (Provincial Water Administration)	hugorohrmann@ecomchaco.com.ar	http://www.ecomchaco.gov.ar/apa
Córdoba	*Dirección Provincial de Agua y Saneamiento* (Provincial Water and Sanitation Directorate)	---	---
Corrientes	*Instituto Correntino del Agua y del Ambiente* (Water and Environment Institute of Corrientes Province)	icaa@arnet.com.ar	---
Entre Ríos	*Dirección de Hidraúlica* (Hydraulics Directorate)	hidro_der.@ciudad.com.ar	http://www.entrerios.gov.ar/medioamb/inicio.htm
Formosa	*Dirección de Recursos Hídricos* (Water Resources Directorate)	---	---

Jurisdiction	Management body	E-mail	Website
Jujuy	*Dirección Provincial de Recursos Hídricos* (Provincial Water Resources Directorate)	---	---
Misiones	*Instituto Misionero de Agua y Saneamiento* (Water and Sanitation Institute of Misiones Province)	imas@misiones.gov.ar	http://imas.org.ar
Salta	*Agencia de Recursos Hídricos* (Water Resources Agency)	agenciarh@copaipa.org.ar	---
Santa Fe	*Dirección de Obras Hidráulicas* (Hydraulics Works Directorate)	dpohsfe@ceride.edu.ar	http://www.santafe.gov.ar/mospyv/dpoh/leyes_dpoh.html
Santiago del Estero	*Administración Provincial de Recursos Hídricos* (Provincial Administration of Water Resources)	subsec_opublicas@arnet.com.ar	---
Tucumán	*Subsecretaría de Recursos Hídricos, Energéticos, Minería y Política Ambiental* (Undersecretariat of Water and Energy Resources, Mining and Environmental Policy)	curahd@tucbbs.com.ar	---

4.1.3.2. Bolivia

Over the last few years, the Bolivian State has carried out a process of administrative decentralisation. One of the major aspects in such a process has been municipalisation, which has defined the municipality as the geographic and administrative entity for management and development. In order to play this role, municipal governments received new administrative and planning powers, among which it is worth to mention the creation of a Municipal Development Plan, which must direct public investments within the municipality (ADSIB, 2005).

The Popular Participation Act of 1994 and the Municipalities Act of 1999 state that the Municipal Government is responsible for environmental and natural resources management in the setting of its own jurisdiction (ADSIB, 2005).

Through the Popular Participation Act, a redistribution of public funds was carried out proportionally to the number of inhabitants in each municipality. This allowed an enormous expansion of investments in most of the more than 300 municipalities into which the Bolivian territory was divided. The Popular Participation Act, moreover, created formal mechanisms (*Organizaciones Territoriales de Base*, OTBs -Base Territorial Organisations-) for the public participation in the development planning and in the investment policy of the municipalities (ADSIB, 2005).

As from the 1992 Environment Act, the planning of land use and of territory occupation has been a basic tool for sustainable development planning. Municipal governments must formulate and apply their *Planes Municipales de Ordenamiento Territorial,* PMOT (Municipal Plans on Territorial Planning), with the aim of organising the use and occupation of their urban and rural territory. Although most of the Bolivian territory already has *Planes de Uso del Suelo,* PLUS (Land Use Plans) at the department level, only very few municipalities have developed their PLUSs or PMOTs (ADSIB, 2005).

The methodology proposed for PMOTs does not explicitly include water management and conservation issues or does it use the basin as a territorial unit. However, it mentions the need to generate a sustainable exploitation of natural resources and to identify risk, vulnerability and ecological fragility areas (ADSIB, 2005).

The Municipalities Organic Act of 1999 does not explicitly assign the responsibility for water management to municipalities either. Nevertheless, municipalities are responsible for the control and/or the provision of drinking water and sewerage services, for the creation of the Municipal Development and Urban and Territorial Planning Plans, and for enforcing the national and municipal water regulations. Municipal water management is further complicated by the fact that, in most cases, municipal borders do not match basin borders (ADSIB, 2005).

Municipalities must coordinate the planning and execution of their activities with the departmental and national levels. In addition, municipalities have the implicit obligation to create a policy that will facilitate water use and management within their own territory, and this policy should be consistent with the Water Plan of the basin(s) that each municipality is a part of (ADSIB, 2005).

The provision of drinking water and sanitary sewerage services is the Municipal Governments' responsibility, according to Law 2,066 and the Municipalities Act. Such responsibility may be carried out directly, through municipal enterprises, through agreements with *Entidades de Carácter Social,* ECSs (Social Status Entities), or through franchises to *Entidades Prestadoras de Servicios de Agua Potable y Alcantarillado Sanitario,* EPSAs (Drinking Water and Sanitation Service Providing Entities), which could be private companies (ADSIB, 2005).

Specifically in relation to irrigation and micro-irrigation systems, municipal governments do not have the legal power or the technical and administrative capacity to operate such systems. It is therefore suggested that this responsibility should be transferred to users. Instead, municipalities can indeed contribute to protecting water sources and hydraulic infrastructure, and they might be the first conciliating instance in case of conflicts between users (ADSIB, 2005).

On the topic of investment, the municipality should be responsible for pre-investment in irrigation, hydropower, drinking water and sanitation projects which fall within its jurisdiction, as well as seek technical support to create those projects, and search for either private or public external funds for their execution, while guaranteeing any required counterpart municipal funds. For projects exceeding their territories, the municipalities should work in association with other municipalities (ADSIB, 2005).

4.1.3.3. Brazil

Given Brazil's federal structure, each State has its own water resources management bodies. Table 4.4 shows the bodies corresponding to the jurisdictions within the La Plata Basin.

Table 4.4. Brazil. Water resources management bodies by state

State	Management Body	E-mail	Website
Federal District (Brasilia)	*Secretaría de Medio Ambiente e Recursos Hídricos* - SEMARH (Secretariat ot Environment and Water Resources)	webmaster@semarh.df.gov.br	http://www.semarh.df.gov.br
Goiás	*Secretaría de Estado do Medio Ambiente e Recursos Hídricos* - SEMARH (Environment and Water Resources Secretariat)	semarh@semarh.goias.gov.br	http://www.semarh.goias.gov.br
Mato Grosso	*Fundação Estadual do Meio Ambiente* – FEMA – *Diretoria de Recursos Hídricos* (State Foundation for the Environment – Directorate of Water Resources)	gabinete@fema.mt.gov.br	http://www.fema.mt.gov.br
Mato Grosso do Sul	*Secretaría Estadual de Meio Ambiente* – SEMA (State Secretariat Environment)	maporto@enersulnet.com.br	http://www.sema.ms.gov.br
Minas Gerais	*Instituto Miniero de Gestão das Aguas* - IGAM (Minas Gerais's Institute of Water Management)	diretoriageral@igam.mg.gov.br	www.igam.mg.gov.br
Paraná	*Superintendência de Desarrollo de Recursos Hídricos e Saneamento Ambiental* - SUDERSHA (Superintendancy of Water Resources Development and Environmental Sanitation)	sudersha@pr.gov.br	http://www.pr.gov.br/sema
Rio Grande do	*Secretaria Estadual do Meio Ambiente* -	jose-wenzel@sema.gov.b	http://www.sema.rs.gov.br

State	Management Body	E-mail	Website
Sul	SEMA (State Environment Secretariat)	r	
Santa Catarina	*Secretaría de Estado do Desenvolvimento Social, Urbano e de Meio Ambiente* - SDS (State Secretariat of Social, Urban and Environmental Development)	dirhid@sds.sc.gov.br	http://www.sds.sc.gov.br
São Paulo	*Departamento de Aguas e Energia Elétrica* - DAEE (Department of Water and Power)	sti@daee.sp.gov.br	http://www.daee.sp.gov.br

Within the borders of their respective States, Water Resources State Councils play a role similar to that of the National Water Resources Council countrywide. Moreover, considering that each State has administrative and budget autonomy, States can organise themselves as is most appropriate. Therefore, structural uniformity in the whole of these councils cannot be expected. A State can even choose not to establish its corresponding council (Praciano Minervino, 2002).

The powers of Water Resources State Councils might also vary from one State to the next, in addition to differing from the CNRH's powers. Yet, it should be pointed out that the work of formulating topics such as the water resources State policy, the main granting and charging guidelines, and the decisions made on relevant conflicts are points that are present among the powers of all the State Councils existing in the country (Praciano Minervino, 2002).

4.1.3.4. Paraguay

The SEAM is decentralised through departmental governments and municipalities. According to Law 1,561/00, departmental governments, through the Government's *Secretaría de Desarrollo Sostenible y Medio Ambiente* (Secretariat of Sustainable Development and Environment), must fulfil the same functions as the SEAM, in a decentralised and participative process (Gamarra Lovera, 2002).

In their municipal organic law, municipalities set forth that they must be in charge of providing water and sanitation services, implementing sustainable use, and be based on the National Environmental Policy (Gamarra Lovera, 2002).

4.1.3.5. Uruguay

In Uruguay, departmental governments are also known as Municipal Intendancies. There are Departmental Boards, which are the legislative and municipal inspection bodies. In some cities in the provinces, there are also Autonomous Local Councils (von Cappeln, 2002).

Municipal intendancies participate in the water resources field, insofar as they regulate internal installations in households and the building of individual sanitation solutions (septic tanks or cesspits), as well as the provision of the service and its corresponding drainage. They also act as promoters for the expansion of water and sewerage services, by building in some cases, with contributions obtained by means of agreements for infrastructure work completion (water and sewerage networks) (von Cappeln, 2002).

4.2. Legislation

4.2.1. National

4.2.1.1. Argentina

There exists no water law at the national level. Over the years, a number of bills for a national or federal water law have been brought forward by either the Executive Power or several legislators, but without the necessary support for any of them to be passed (Calcagno, 2001).

The current national legislation is thus made up of the norms included mainly in the Civil Code, the Commerce Code, the Mining Code, the Criminal Code, and federal norms such as energy, navigation, transport, ports, environment protection and natural resources laws, which contain resolutions directly or indirectly related to water. Also, the Nation has ratified international treaties on shared water; entry of nuclear ships in Argentinean waters; loans for drinking water supply and urban and rural sanitation works; building of multiple use works; and others whose norms involve water, either directly or indirectly (Calcagno, 2001).

Several bills have been debated and consulted on. The “Act Adopting the Water Policy Ruling Principles for the Argentine Republic and other related Matters as the Nation’s Policy Guidelines” bill has been under consideration since May 2005. In addition, tasks were initiated in 1996 for complying with the “minimum environmental protection requirements” included in the National Constitution. The Environment General Act 25,675, enacted on November 27, 2002, provides the framework to start defining minimum environmental protection requirements by sector (Calcagno, 2001).

Law 25,688 was enacted in December 2002. Its regulation still pending, it is called “Water Environmental Management System” and establishes the creation of basin committees for interjurisdictional basins (Calcagno, 2001).

This law has met with extensive criticism. Although with different shades, most provincial water authorities agree that the law infringes on provincial powers not delegated to the Nation as regards basins and basin committee organisation, as well as natural resources management, the development of local institutions, and water planning, use and management. In response to such objections, the National Senate’s *Comisión de Ambiente y Desarrollo Sustentable* (Commission on Environment and Sustainable Development) held a series of meetings aiming at collecting the opinions of provincial and national representatives on water and environmental issues, of representatives of the major interjurisdictional bodies, and of experts in the matter. Later, at the request of this Commission, representatives of the SAyDS and of the SSRH jointly proposed criteria "to be considered in a potential revision of Law 25,688," which are being considered by the aforementioned Commission of the Nation's Senate (Calcagno, 2001).

Even if the law were revised, the enactment of a more encompassing law would still be pending; one with a national scope, which should translate those basic water policy principles shared by all provinces into common norms, which should seek, with a national perspective, to reconcile potentially conflicting issues. It is important to coordinate these principles with the basic facts in the country's economy, with the role water resources may play in this respect, and with water-associated social conditions, as well as with the necessary instruments to put these principles and the cost of their implementation into practice. Without such tasks, the principles' operational role might be restricted (Calcagno, 2001).

Specifically in relation to basin management, there is still no settled planning and management policy with the proper legal, regulatory and budget support, encompassing the whole problem. This leads to some conceptual and institutional dispersal still prevailing at the various levels of jurisdiction associated with this subject. There exist, nevertheless, national laws related in one way or another to basin management, such as Law 13,273 on the Defence of Forest Richness and supplementary norms; Law 24,051 on Dangerous Waste, Law 25,080 on Investments for Cultivated Forests; Law 22,421 on Fauna Protection and Conservation; Law 22,428 on Soil Conservation Promotion; and Law 22,351 on National Monuments, Parks and Natural Reserves.

Provincial water laws or codes set the priorities for water use, rank uses and regulate the concessions regime, setting forth the fashion, timeline and procedures to grant use and discharge permissions and concessions, collection of fees, taxes and other contributions; and establish sanctions and penalties, including franchise termination. In general, they are rigid instruments that do not take into account the economic, social and environmental value of water (Calcagno, 2001).

At the municipal level, the organisation and capacities regarding water resources management are highly variable depending on the category of the municipality, provincial legislation and economic capacity. In most cases, they are very limited, except in large urban conglomerates. The decentralisation of drinking water and sanitation services and their transference to the private sector are forcing an adjustment of these roles and a need for significant institutional strengthening (Calcagno, 2001).

4.2.1.2. Bolivia

There is no main legal body functioning in Water Law terms in Bolivia. The original legislation, partly annulled by later resolutions, dates back to 1906 and is a revision of a legal resolution of 1879 (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

Since the 1970s, attempts to formulate water legislation have been unsuccessful. A total number of 32 draft bills have accumulated, none of which was approved due to lack of consensus or to document inadequacy (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

One of the causes of this difficulty to formulate a water law may lie in the disparity of views on the character of water as a good and on aspects of rights of use. Water is seen as a collective good, an economic good with social value, a good that is liable to turn into a private good, and very rarely as a public good. Furthermore, there is an aboriginal-rural sector that defends native peoples' rights on water exploitation and demands recognition of customary ways of accessing water (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

There exist large quantities of sectorial laws that, in one way or another, define different water-sector aspects and create a puzzling and disperse jurisprudence. Since 1990, and as from the process of state reformulation, several legal resolutions have been issued affecting the sector (see Table 4.5)

Table 4.5. Bolivia. Legal resolutions affecting the water sector

Year	Resolution
1993	Popular Participation Act
1993	Environment Act
1994	System of Sectorial Regulation Act (SIRESE)
1994	Electricity Act
1996	Forest Act
1996	Service of Agrarian Reform Act
1997	Mining Code
1997	Protected Areas Regulation
1997	Use of Public Domain Goods Regulation
1998	Norms for the Use of Irrigation Water
1999	Municipalities Act
2000	Drinking Water Act

Source: Unidad de Desarrollo Sostenible y Medio Ambiente, 2002

Authorisations for the exploitation of water resources come from different entities, depending on the case, and the legal framework could be provided by the Drinking Water Act, the sectorial Superintendence, the Mining Code, the Protected Areas Regulation, or other resolutions (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

4.2.1.3. Brazil

Brazil has highly developed the water resources legislation. As an example, some laws, decree-laws, decrees and resolutions are listed in Table 4.6.

The International Water Resources Treaties signed by Brazil are:

- Treaty of the La Plata Basin
- Treaty of the Paraná River (on Itaipú)
- Treaty of the Uruguay River and its tributary the Peperi-Guaçu River.

- Treaty of the Quaraí River Basin

Table 4.6. Brazil. Legal resolutions affecting water sector

Resolution	Date	Subject
Law 5,318	09/26/67	It establishes the National Sanitation Policy and creates the National Sanitation Council
Law 6,225	07/14/75	It contains provisions on region discrimination by the Ministry of Agriculture for mandatory execution of land protection plans and erosion fighting.
Law 6,662	06/25/79	It contains provisions on the National Irrigation Policy.
Law 6,938	08/31/81	It contains provisions on the National Environment Policy, its goals and formulation and enforcement mechanisms.
Law 7,754	04/14/89	It sets measures for the protection of forests in the headwaters of Rivers.
Law 7,797	07/10/89	It creates the National Environment Fund.
Law 7,804	07/18/89	It revises Law 6,938/81, governing the National Environment Policy, its goals and formulation and enforcement mechanisms; Law 7,735/89; Law 6,803/80; and Law 6,902/81.
Law 9,795	04/27/99	It contains provisions on environmental education; establishes the National Environmental Education Policy and other measures.
Law 9,993	07/24/00	It allocates financial compensation resources for the use of water resources with the aim to generate electric power and for the exploration of mineral resources for the science and technology sector.
Decree-Law 1,413	08/14/75	It contains provisions of the control of environment pollution caused by industrial activity.
Decree 76,389	10/03/75	It contains provisions on prevention and control measures for industrial pollution referred to by Decree-Law 1,413/75
Decree 89,336	01/31/84	It contains provisions on Ecological Reserves and Areas of Relevant Ecological Interest.
Decree 89,496	03/29/84	It regulates Law 6,662, of 06/25/79, with provisions on the National Irrigation Policy.
Decree 94,076	03/05/87	It establishes the National Micro-basins Programme.
Decree 95,733	02/12/88	It contains provisions on the inclusion within federal projects and works budget, of resources aimed at preventing or repairing environmental, cultural and social damage deriving from those projects and works.
Decree 97,822	06/08/89	It establishes the *Sistema de Monitoramiento Ambiental e de los Recursos Naturais por Satellite* (SIMARN, Satellite Environmental and Natural Resources Monitoring System)
Decree 99,274	06/06/90	It regulates Law 6,902/81 and Law 6,938/81, with provisions on the creation of ecological stations and areas of environmental protection; and the national environment policy and other measures, respectively.
Resolution 536	12/07/76	Ministry of Domestic Affairs – It establishes quality standards for surface water in the Brazilian territory.
Resolution 407	11/23/99	Ministry of the Environment – It approves the Internal Regulation of the National Water Resources Council.
Resolution 3	09/18/85	*Conselho Nacional do Meio Ambiente*, CONAMA (National Environmental Council) - It creates a Special Commission to propose the zoning of the Paraguay River Basin.
Resolution 20	06/18/86	CONAMA - It establishes the classification of fresh water and brackish and saline water in the national territory.

Source: Secretária de Recursos Hídricos, 2005 a.

4.2.1.4. Paraguay

There is no General Water Law in Paraguay. The current set of norms on water management has sectorial characteristics, with overlaps in a large number of laws. At the beginning of 2000s, there were two Water Law bills under analysis by the Nation's Senate (Gamarra Lovera, 2002).

Regarding controversies over the use of water, these are taken into account in a 1949 Decree-Law establishing, among other things, a *Consejo del Agua* (Water Council) for conflict management and solution in the case of exploitation for agricultural use (rice irrigation) (Gamarra Lovera, 2002).

The main norms in force are (Gamarra Lovera, 2002):

- *Law 1,183/85*, Civil Code, considers surface water to be the domain of the state and inalienable, imprescriptible and not susceptible to be seized. Its use is regulated. However, it is unclear with respect to groundwater.

- *Law 1,248/31*, Rural Code, establishes the regime to exploit public water in rural areas. It also sets forth the procedures for concessions and includes regulations for water quality protection. In addition, it refers to the concession of special exploitations, establishing the order of priority for water use. Finally, it states that, in times of extraordinary drought, the Executive Power may decide on temporarily expropriating the necessary water for supplying the population.

- *Law 836/80*, Sanitary Code, establishes regulations for drinking water supply and sanitation.

- *Decree-Law 3,729* sets norms for public water management. It has also been used for water management over the past fifty years. It should be pointed out that it states water's public domain and ways to request it, and it classifies contraventions and offences. It establishes punishments and creates the institutional basis for rights of use or concessions.

- *Law 294/93*, on Environmental Impact Assessment, establishes an environmental impact assessment for those works that might alter the hydrological regime.

- *Decree 281/96,* regulating Law 294/93, of environmental impact assessment, states that environmental impact assessment is an environmental policy tool made up of a set of procedures that can guarantee, from the beginning of the process, a systematic analysis of the environmental impacts of a proposed action (whether it be a project, a programme, a plan or a policy) and its alternatives.

- *Law 1,160/97*, Criminal Code, classifies and punishes several reprehensible behaviours affecting the environment. It establishes penalties of up to 10-year imprisonments for altering the natural regime of water sources or watercourses without authorisation, and for the discharge of raw effluent, but its implementation is only incipient.

- *Law 1,614/01* on the ERSSAN is a sectorial law regulating the service of drinking water supply and sanitary sewerage. This law was mainly created with the purpose of promoting private participation in the drinking water supply and thus increasing service coverage.

- *Law 1,561/2000*, creating the SISNAM, the CONAM and the SEAM. This law aims to create and regulate the operation of bodies in charge of generating, standardising, coordinating, executing and inspecting the national environmental policy and management.

- *Municipal Organic Law 1,294/87*, Section 18, determines that municipal functions include, among others, the provision of water supply and sewerage services, for cases in which such services are not provided by other public bodies, and a local regime of easement and of river, lake and stream bank demarcation, in accordance to the Civil Code.

- *Law 716/96*, punishing offences against the environment, protects the environment and human quality of life against those who might direct, execute or -making use of their powers- allow or authorise any activities against ecosystem balance, natural resources sustainability or human quality of life.

- *Resolution 222/02* is the existing legal regulation on water quality at the ministerial resolution level. It establishes the Water Quality Standard and defines the norms for waste dilution.

4.2.1.5. Uruguay

The Water Act and the instruments for its effective application endeavour to adjust to the Uruguay's specific characteristics and circumstances, while also taking into account its institutional and budget capabilities. Even though there are several aspects to be improved, the legal framework related to water resources management is orderly and has generally achieved a high degree of observance (von Cappeln, 2002).

Regulatory support for water resources management is found at all hierarchical levels of legal norms: Constitution, laws and regulations:

- *Constitution of the Republic, Section 47 (1996 Reform)*, declares environmental protection of general interest and prohibits any actions seriously affecting the environment.

- *Water Code, Decree-law 14,859, of 12/15/78*, establishes the Executive Power's authority and responsibilities to administrate the country's water, in connection with its quantity and quality, and sets drinking water supply to towns as the first priority for its use.

- *Environment Laws 16,170, of 12/28/90; 16,466, of 1/19/94, of Environmental Impact*, regulated by Decrees 435/94, of 9/21/94, and 17,283, of 11/28/00, of Environmental Protection.

- *Irrigation Law 16,858, of 09/03/97*, regulates the construction of hydraulic developments and the exploitation of irrigation water. It is regulated by Decree 404/01, of 10/11/01

- *Law of Water Domain 17,142*, of 7/23/99

- *Law of Soil and Water Conservation 15,239,* of 12/23/81, regulated by Decree 284/90, of 6/21/90

- Executive Power decrees regulating water heritage management, use and protection aspects:

- Prevention of water pollution, Decree 253/79, of 5/9/79, and amendments.
- Sanctions for contravening the Water Code, Decree 123/99, of 4/28/99.
- Guaraní Aquifer Management Plan, Decree 214/00, of 7/26/00, and complementary.

Water Code implementation does not go against the general regulations included in the Civil Code with respect to the public and private domain and easements (von Cappeln, 2002).

The weakest point in regulation within the Uruguayan legal framework lies in the water property rights legal regime, which is of mixed –public and private– nature. In this sense, by not taking into account that, due to its characteristics, water property is not analogous to the common property regime in Uruguayan law, jurisprudence tends not to acknowledge the importance of rational and sustainable water exploitation. For this reason, as a consequence of the resistance to accept Administration instructions regarding private domain water, law interpretations are developed, which prioritise private interests over collective interests (von Cappeln, 2002).

Section 15 of the Water Code sets as one of the criteria to determine domain that water not incorporated into the property of private persons by the date of the Code is a part of the public domain. With respect to the remaining waters, it contains specific previsions depending on whether it refers to rivers, streams, pluvial, lakes, spring or ground waters etc, making for a confusing delimitation. In the case of rivers or streams, the differentiation criterion is associated with their navigability or floatability, a matter not defined by the law (von Cappeln, 2002).

However, this is not applicable in surface water destined to irrigation or hydroelectricity, whose status will always be public according to clause number 22 of Decree-law 10,582, of 12/23/44. The norm states that, regarding the construction of irrigation and energy exploitation works, the state owns the water in all rivers and streams, therefore involving those from non-navigable and non-floatable ones (von Cappeln, 2002).

4.2.2. Federal

4.2.2.1. Argentina (provincial legislation)

Until late 2002, all Argentinean provinces, except for Santa Fe and Tierra del Fuego, and also the City of Buenos Aires, had specific Water Codes or Laws. The latest Argentinean water law is the Buenos Aires Province Water Code, of the year 2000 (Calcagno, 2001).

The lengthy water laws of the first half of the twentieth century referred to all the traditional aspects (public and private, surface and ground waters; water quality; police power; concessions for water use; canon; priorities; easements, etc.) and water uses known to the moment, as well as to the organisation of its administration (Calcagno, 2001).

During the last third of the twentieth century, laws were promulgated considering water as a natural resource contained in the environment. These laws incorporate modern notions such as water policy and planning, water emergencies, definition of water risk prone areas, environmental impact, concessions of works and services associated with water, water record and land register, more flexible priorities of use, creation of basin committees, inter-provincial water, protection of surface water sources and aquifers, basins as planning and administration units, etc. (Calcagno, 2001).

4.2.2.2. Brazil

In Brazil, each State has abundant legislation associated with water resources. As an example, a few norms are listed below, by state (Praciano Minervino, 2002):

Mato Grosso

- Law 6,945, of 11/05/1997. It contains provisions on the Water Resources State Policy, establishes the Water Resources State System and implements other measures.
- Law 8,097, of 03/24/2004. It contains provisions on the Administration and Conservation of Groundwater of state domain and implements other measures.
- Decree 3,952, of 03/06/2002. It regulates the *Consejo Estadual de Recursos Hídricos* (State Water Resources Council) of Mato Grosso State.

Mato Grosso do Sul

- Decree 10,663, of 01/24/2002. It establishes a special fishing and navigation regime in the Salobra River and in Córrego Azul, and implements other measures.

Federal District

- Decree 22,356, of 08/31/2001. It regulates the Federal District Water Resources Information System, and implements other measures.
- Decree 22,359, of 08/31/2001. It contains provisions on the awarding of water resources use rights in the territory of the Federal District, and implements other measures.

Goiás

- Law 13,025, of 01/13/1997. It contains provisions on fishing, aquaculture and protection of aquatic fauna.

Minas Gerais

- Law 10,793, of 07/02/1992. It contains provisions on the Protection of Springs destined to public supply in the State.
- Law 13,194, of 01/29/1999. It creates the *Fundo de Recuperação, Proteção e Desenvolvimento Sustentável das Bacias Hidrograficas do Estado de Minas Gerais*, FHIDRO (Recovery, Protection and Sustainable Development Fund for the River Basins of Minas Gerais State) and implements other measures (modified by Law 13,255/99).

São Paulo

- Decree 28,489, of 06/09/1988. It takes the Piracicaba River Basin as a Basic Model for Water Resources Management purposes, and implements other measures.

Paraná

- Decree 2,316, of 07/18/2000. It regulates the Participation of Water Resources Civil Organisations in the State's Water Resources Management System.
- Decree 4,646, of 08/31/2001. It contains provisions on the Water Resources Use Rights-Granting Regime.

Santa Catarina

- Decree 1,669, of 04/14/2004. It creates the *Programa para o Desenvolvimento Sustentável da Bacia do Rio Uruguai – Pro Río Uruguai-Acuífero Guarani* (Programme for the Sustainable Development of the Uruguai River Basin – Pro Uruguai River-Guarani Aquifer).

Rio Grande do Sul

- Law 8,850, of 05/08/1989. It creates *the Fundo de Investimento en Recursos Hídricos do Rio Grande do Sul* (Rio Grande do Sul Water Resources Investment Fund).

4.2.3. Local

- <u>Argentina</u>

At the municipal level, the organisation and capacities regarding water resources management are highly variable depending on the category of the municipality, provincial legislation and economic capacity. In most cases, they are very limited, except in large urban conglomerates. The decentralisation of drinking water and sanitation services and their transference to the private sector are forcing an adjustment of these roles and a need for significant institutional strengthening.

4.3. Human Resources

4.3.1. Argentina

Approximately 120 people work at the SSRH of the MINPLAN. There is no information in connection with other national or provincial bodies.

4.3.2. Brazil

Approximately 140 people work at the SRH of the MMA. The ANA has 420 civil servants. There are no data as regards the states.

4.3.3. Paraguay

This is the country's weakest area. Many technicians are interested in the water resources area, but very few have the necessary training.

4.3.4. Uruguay

The DNH has 500 civil servants, of whom 55 work in the *Departamento de Recursos Hídricos* (Department of Water Resources); 55% of these are professionals and technicians and 45% carry out support tasks. Also, owing to operational decentralisation, 30 of the 55 civil servants are at the 7 regional offices of the national provinces on a permanent basis.

The DINAMA has 80 civil servants, of whom 70% are professionals and technicians, while 30% are specialised and support workers.

4.4. Goals and Programmes

4.4.1. National Goals and Programmes Currently in Progress

4.4.1.1. Argentina

- *Política Nacional de Desarrollo y Ordenamiento Territorial* (National Policy of Territorial Development and Planning)

The Argentinean national government is working on this plan, whose goal is to reorganise the territory, orienting it towards a balanced, integrated, sustainable development, with social justice, on the basis of exploiting the different comparative advantages and the human potential in each region. At the end of 2004, the MINPLAN prepared a document titled "*Argentina 2016. Política y Estrategia Nacional de Desarrollo y Ordenamiento Territorial. Construyendo una Argentina equilibrada, integrada, sustentable y socialmente justa*" (Argentina 2016. National Policy and Strategy of Territorial Development and Planning. Building a balanced, integrated, sustainable and socially fair Argentina) (Ministerio de Planificación Federal, Infraestructura y Servicios, 2004).

As specific aims, it states that, by 2016 –the year of the two hundredth anniversary of the declaration of independence–, each inhabitant in the country should have developed their territorial and cultural identity, as well as their sense of belonging to the national territory; reach economic progress according to their personal projects and capacities without the need to abandon their region of origin; achieve environmental sustainability to guarantee present and future resource availability; fully participate in the democratic management of the territory at all levels; have access to essential goods and services, allowing personal and collective development, and a high quality of life in all corners of the country (Ministerio de Planificación Federal, Infraestructura y Servicios, 2004).

- *Plan Federal de Control de Inundaciones*, PFCI (Federal Flood Control Plan)

Decree 1,381, of November 1st, 2001, established the Water Infrastructure Tax for the whole national territory, with the goal of promoting the development of any projects of water work infrastructure aiming at recovering productive lands, mitigating floods in rural areas, and drainage and protection of road and railway infrastructure in rural and periurban areas, starting by those regions that were in water emergency at the time (SSRH, 2005).

The enforcement of this Decree led to a large number of works being resumed and to others being initiated in various productive areas in several provinces, among them Buenos Aires, Córdoba, Formosa and Santa Fe. The works in question are related to regulation, city's defences, construction and refurbishing of pipelines, dredging, bridges, etc. (SSRH, 2005).

- *Programmes funded by multilateral credit bodies*

The meteorological emergency brought about by the "El Niño" phenomenon, which took place between August 1997 and April 1998, caused severe damage in the North-eastern littoral of Argentina, which involved the destruction of productive sources and of infrastructure in Formosa, Chaco, Misiones, Corrientes, Entre Ríos and Santa Fe provinces. The climate emergency also affected regions in Córdoba, La Pampa, Chubut and Santiago del

Estero provinces. The floods led to the evacuation of over 150 thousand people, and damages were estimated at US$ 2,084.3 million (UCPFE, 2005).

The Nation asked the Inter-American Development Bank (IDB) for financial assistance, and Loan Contract Number 1,118/OC-AR was entered into, in order to partially finance the *Programa de Emergencia para la Recuperación de las Zonas Afectadas por las Inundaciones* (Emergency Programme for the Recuperation of Areas Affected by Floods). This aims to support the economic and social recovery of those areas affected by the flood, by carrying out activities for the mitigation, reconstruction and rehabilitation of the economic and social infrastructure, as well as the design of prevention activities to reduce damage by potential similar phenomena in the future (UCPFE, 2005).

Of the loan's US$ 300 million, 265.4 million are allocated for reconstruction, and 25 million for prevention. The local counterpart is US$ 200 million.

Also, through the Argentinean Nation, Buenos Aires, Chaco, Corrientes, Entre Ríos, Formosa, Misiones and Santa Fe Provinces, and the City of Buenos Aires asked the International Bank for Reconstruction and Development (IBRD) and the Export-Import Bank of Japan (JEXIM) for financial assistance. The Loan Contract IBRD/JEXIM 4,117-AR (UCPFE, 2005) was thus entered into for financing the *Programa de Protección contra Inundaciones* PPI (Flood Protection Programme). The sums involved are US$ 200 million (IBRD), US$ 100 million (JEXIM) and US$ 100 million (provincial counterpart) (UCPFE, 2005).

Similarly, through the Argentinean Nation, and Salta, Tucumán, Chaco, Córdoba and Misiones provinces, among others, asked IBRD for financial assistance. Loan Contract IBRD 4,273-AR (UCPFE, 2005) was thus entered into, in order to finance the *Programa de Protección de Emergencia de Inundaciones "El Niño"* ("El Niño" Flood Emergency Protection Programme). The financing sum is US$ 420 million.

- *Ente Nacional de Obras Hídricas de Saneamiento,* ENOHSA (National Agency of Water Works for Sanitation)

In the drinking water and sanitation sector, the investments forecasted by ENOHSA for 2005, through the different programmes it is in charge of, added up to AR$ 251,360,025. The level of investment is distributed in 386 projects, 10 of which correspond to projects financed with resources from Multilateral Credit Bodies (IDB - IBRD) for a sum of $ 38,952,000, whereas the other 376 are financed with resources from the National Treasury or with the body's own resources. In addition, *Fortalecimiento Institucional para los Entes Reguladores de los Servicios de Saneamiento* (Institutional Strengthening for Sanitation Services Regulatory Entities) projects are being carried out in 8 provinces with IDB resources through FOMIN ATN/MN 6,261 AR funds (ENOHSA, 2005).

4.4.1.2. Brazil

- *Plano Nacional de Recursos Hídricos,* PNRH (National Water Resources Plan)

The National Water Resources Plan is one of the National Water Resources Policy's tools. The SRH coordinates its creation, and proposed the dynamics of the planning process in the setting of the 12 Hydrographic Regions, structured in these lines: National Vision; Strategic

Diagnosis; Water for the Future: a Vision for 2020; Instructions and Goals, and National and Regional Programmes (Secretaría de Recursos Hídricos, 2005 b).

The publication of the Reference Basis Document has the aim to start an extensive discussion with the society in order to reach commitment solutions, considering water supply management in quantitative and qualitative terms, and the demand for the different uses of water resources (Secretaría de Recursos Hídricos, 2005 b).

It is considered that the creation of the National Water Resources Plan is a process that must be carried out progressively, in phases of gradual improvement. The address *http://pnrh.cnrh-srh.gov.br* has been made available for accompanying, making suggestions on and perfecting the Plan's construction process (Secretaría de Recursos Hídricos, 2005 b).

- *Pantanal Programme*

The Pantanal Programme is being carried out by the MMA, in the setting of the *Secretaría da Calidade Ambiental nos Asentamentos Humanos* (Secretariat of Environmental Quality in Human Settlements). The governments of Mato Grosso do Sul and Mato Grosso states, and the IBAMA are co-executing the Programme. Its aims are: (1) to manage the Alto Paraguai Basin and the critical sub-basins in order to reduce sedimentation and pollution from agriculture and mining, increasing production and productivity, conserving biodiversity and offering a better quality of life to the population; (2) to promote planning and drainage in urban areas and to define a strategic solid waste management plan, reducing organic and industrial pollution in sub-basins and improving water quality; (3) to stimulate the practice of economic activities which are environmentally suitable for the Basin's ecosystems; (4) to support the consolidation and creation of environmental conservation areas.

- *Groundwater Programme*

The *Programa de Aguas Subterráneas,* PAS (Groundwater Programme) of the SRH aims at promoting actions which allow the construction of a managerial framework for Brazil's groundwater, serving as a basis for the protection, conservation, and systemic, integrated and participative management of aquifers and groundwater in general.

That involves expanding the basic hydrogeological knowledge, favouring institutional and legal construction and strengthening, subsidising and promoting management and formulating groundwater public policies, made compatible with national and State water resources policies and with the participation of the municipality, tending to the sustainable development of the hydrogeological provinces.

Within this notion, and given the country's amplitude, the PAS has been divided into the Basin Knowledge, Legal and Institutional Aspects, Social Mobilisation, Transboundary Aquifer Management, and National Conflicts subprogrammes.

4.4.1.3. Paraguay

A strengthening programme by the SEAM is going on, with the IDB's financial support, working on the SEAM's decentralisation process, strengthening the Municipalities and governments (Gamarra Lovera, 2002).

It is also important to mention the decontamination plans for the Mburicao Stream –a Paraguay River tributary– with the Asunción Municipality, with FONPLATA funds.

4.4.1.4. Uruguay

The major problems are related with water and poverty issues, and they are found in

(a) coverage of the sewerage network;
(b) sewage treatment;
(c) urban drainage; and
(d) floods in urban and suburban areas.

PART C: CHALLENGES TO LIFE AND WELL-BEING

Challenge: Water and Health

Overview: This particular challenge area focuses on the need to recognize that access to safe and sufficient water and sanitation are basic human needs and are essential to health and well-being, and to empower people, especially women, through a participatory process of water management.

5. Water for basic needs and health

5.1. Water consumption in the La Plata Basin

Little information about per capita water consumption in the La Plata Basin is available. According to the data collected, only estimated results have been obtained for Argentina, Brazil and Bolivia. As for Argentina, water consumption is estimated at 180 litres per capita (lpc) on a daily basis, in Bolivia, 130 lpc/day and in Brazil, 141 lpc/day (Mugetti, 2004; Crespo Milliet, 2004; PMSS, 2004). In Brazil, this information is divided into large regions. Brazilian regional details for the La Plata Basin are listed below (PMSS, 2004):

Brazil:
South-eastern region: 174 lpc/day
Southern region: 124.6 lpc/day
Centre-western region: 133.6 lpc/day

Water use by country for year 2000 was estimated according to the information shown in Table 5.1.

Table 5.1. La Plata River Basin. Total water use by country (km^3/year). Estimated data for year 2000.

Countries	Total use	Agricultural use		Domestic use		Industrial use	
		Total	%	Total	%	Total	%
Argentina	29.07	21.52	74	4.79	16	2.76	9
Bolivia	1.39	1.16	83	0.18	13	0.05	3
Brazil	59.30	36.63	72	12.02	20	10.65	18
Paraguay	0.49	0.35	75	0.10	20	0.04	18
Uruguay	3.15	3.03	96	0.08	2	0.04	1

Source: FAO, 2005 b

In the Paraná River Basin, the thriving socioeconomic development of São Paulo, Minas Gerais and Paraná (Brazil) as well as of the Argentinean provinces on the "Industrial fluvial front[17]" determines the relatively high percentage of water consumption for domestic and

[17] The Fluvial Industrial Front is the local name given to the macro urban area formed by the Great La Plata, the Buenos Aires Metropolitan Area, the Great Rosario and the Great Santa Fe. Financial centres, food,

industrial use. The greatest demand is concentrated in the Tietê River Basin, where it outstrips water availability. Regarding consumptive uses, the Tietê sub-basin –in São Paulo Metropolitan Area– accounts for the greatest demand for urban, rural and industrial use, being the resource highly compromised in terms of demand/availability ratio (Tucci, 2004).

The same situation, in which domestic consumption is important, is present in Paraguay, where it is predominant over other consumptive uses. Conversely, domestic use has a lower relative weight in Bolivia where agricultural irrigation uses are predominant (Tucci, 2004).

In the Paraguay River Basin, water consumption for human supply is generally of lower relative weight than other consumptive uses, agriculture ranking first. The agricultural use predominates in the Paraguayan, Bolivian and Brazilian sections of the basin.

In the Uruguay River Basin, the scenario is similar to the Paraguay River Basin, since the water destined to the agricultural sector has a greater relative weight over the rest. Both the urban and rural supply use 10.7 m^3/s, which accounts for nearly 4% of the total demand. The use for urban supply is greater in the Ibicuí River Basin, in Brazil (Tucci, 2004).

5.2. Quality and quantity of water

In general, the quality of drinking water supplied to urban areas in Argentina, Brazil and Uruguay is adequate for human consumption, since water treatments are carried out in the three riparian countries, to make its distribution and use possible. The data available for Paraguay is not enough to evaluate the physical, chemical and bacteriological quality of the water. However, it is a fact that 100% of urban users who rely on the service receive treated water (Teixeira et al., 2000). Finally, in Bolivia, the situation is rather heterogeneous since departmental capitals have much superior coverage as compared to intermediate cities, although this does not necessarily guarantee the quality of the service. For instance, while the quality of the service in Potosí City is poor and shows water quality deficiencies, Villazón City has very good quality levels (Orozco et al., 2000). Production of water in Bolivia reaches 1,158 l/sec in the Paraguay River Basin (Crespo Milliet, 2004).

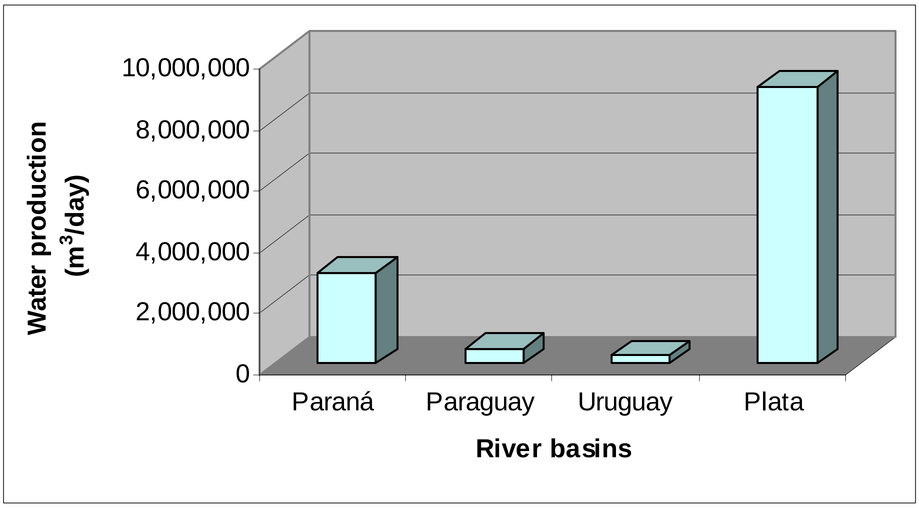
On the other hand, there are particular cases which might affect water quality. For example, in Argentina, only 10% of the total volume of wastewater collected by the sewerage systems is treated, while the remaining volume is dumped into watercourses, which derives in serious water contamination problems. This fact is worsened when such watercourses are also used as a drinking water supply source. The most paradigmatic cases are illustrated by the Buenos Aires Metropolitan Area and the Great La Plata, both located on the La Plata River banks (Castro, 2000); in fact, the La Plata River systems represent the most important source of water production in the Argentinean sector of the La Plata Basin (see Figure 5.1).

In general, the distribution of the service is continuous in all the countries along the year. However, there are some difficulties during the summer months, when consumption tends to

metallurgical and fuel industries, governmental institutions, infrastructure, educative centres and several harbours –including the Buenos Aires one– are located in this area.

increase. In Paraguay and Uruguay, water pressure gets lower, affecting supply (Texeira, 2000; Salvatella Agrelo, 2000). Usage restrictions are imposed in Uruguay to prevent water shortages in networks located in places where water availability is insufficient in days of peak consumption; in such cases, the use of drinking water is prohibited or limited for a number of uses –irrigation, washing of sidewalks or vehicles, etc.–. The enforcement of these restrictions has been reduced gradually in the last years of 1990 decade. However, some services still have localised supply problems due to the distribution network being insufficient, which results in low pressures available in areas that are high or distant from distribution points (Salvatella Agrelo, 2000). Production of water in Uruguay reaches 200 l/day in the La Plata River System and 120 l/day in the Uruguay Basin (Tucci, 2004).

Figure 5.1. Argentina. Water production by sub-basin.



Source: Mugetti, 2004

In rural areas, the situation is quite different. For instance, in Paraguay, the percentage of population with access to safe water is very high, around 90% (Texeira, 2000). At the same time, there is a lack of information about the amount of systems that provide water 24 hours a day, how many are used for more than 12 hours and how many for less than 12 hours. According to unconfirmed information, most of such systems supply water 24 hours a day, some for more than 12 hours and none for less than 12 hours (Texeira, 2000).

As regards the quantity of water, Paraguay is the country that has the greatest superficial water availability in South America (67,000 m^3/inhab/year), with an even greater concentration of such availability in the Eastern sector (Tucci, 2004).

In the Uruguay River Basin, water availability is enough to cover water supply. However, during low-water periods and in the small headwaters basins, there may be specific conflicts, mainly considering that groundwater availability is low in that region since the Uruguay River basin lies almost completely on a basaltic formation (Planalto hydrogeologic unit) where wells have low production capacity –between 3 and 5 m^3/h–. On the other hand, there are studies which prove that meeting the demand for human supply is simply a matter of investment in regulation (Tucci, 2004).

5.3. Existence of monitoring mechanisms and standards

Given the diversity of monitoring mechanisms and the application of standards to water supply and sanitation, the situation in each riparian country will be described separately.

- Argentina

In Argentina, public network supply systems treatment is performed in compliance with public health standards set forth in the *Código Alimentario Nacional* (National Food Code). In turn, Water Quality Standards by the World Health Organization and U.S. Environmental Protection Agency are also complied with. Likewise, drinking water supply is usually running 24 hours a day (Castro *et al.*, 2000).

On the other hand, only 10% of the total volume of wastewater collected by sewerage systems gets purification treatment. Buenos Aires, La Plata and Rosario cities dump their sewage effluents without previous treatment, or when they do, only a minimum amount of the total volume collected is purified. The technologies most frequently used for purification of excreta are stabilisation lagoons and digested sludge, and less frequently, trickle beds and oxidation ditches (Castro *et al.,* 2000).

In 1993, when the privatisation process of the sector's entities started, the institutional web increased its volume and complexity as private operators and regulatory agencies came into play. In general terms, there is a clear division between "sanitation" entities, in charge of delivering drinking water and sewer drainage services, and "water" entities responsible for construction works, hydrological measurement, protection against floods, etc. (Mugetti, 2004). The national institutions responsible for monitoring and controlling the quality of the services are the Regulatory Entities of the service (Castro *et al,* 2000).

- Bolivia

In Bolivia, the delivery of drinking water and sewerage services in urban areas is rather heterogeneous not only in terms of its management administrative modalities but also in terms of quality and coverage. In rural areas, the existing systems have been developed with foreign aid (UNICEF, PAHO) and they have technologically appropriate characteristics and low cost.

As regards the sewerage system, the situation is much less promising than that of drinking water. Some Departmental capitals do not have sewerage service and in the remaining major cities, coverage is poor. Therefore, the population has to rely on isolated systems such as septic tanks, latrines, or eventually, in open dumps. On the other hand, those cities that have sewerage systems do not perform wastewater treatment due to its high cost; however, there are also major cities such as Tarija where water is treated either partially or totally in stabilisation lagoons (Orozco *et al.*, 2000).

The State's reformulation process gave way to the enactment of laws linked to the water sector, among which is the so-called *Ley de Agua Potable de 1990* (Drinking Water Act, 1990). In this area, the regulatory responsibility is in the hands of the *Ministerio de Vivienda y*

Servicios Básicos, MVSB (Ministry of Housing and Basic Services) and monitoring and control is in charge of the *Superintendencia de Servicios Básicos* (Superintendance of Basic Services) (Crespo Milliet, 2004).

-Brazil

Although it has been set that it is within the Municipality's responsibility to organize and deliver services of local interest (either directly or indirectly, by means of concessions or permissions, and maintaining their responsibility in regulation and monitoring activities, which pertain to the public power and are not to be delegated, e.g. basic sanitation), jurisdiction has not been clearly defined yet due to the lack of regulation of constitutional precepts and absence of federal laws with provisions on this matter (Fonseca & Medeiros da Silva, 2000).

Sanitation service delivery is predominantly centralised in the 27 state sanitation companies, nine of which serve the states of the La Plata Basin. They are *Companhia de Saneamento de Brasilia*, CAESB (Sanitation Company of Brasilia), *Compañía Catarinense de Águas e Saneamento*, CASAN (Water and Sanitation Company of Santa Catarina), *Companhia de Saneamento de Minas Gerais*, COPASA (Sanitation Company of Minas Gerais), *Companhia Riograndense de Saneamento*, CORSAN (Sanitation Company of Rio Grande do Sul), *Companhia de Saneamento Básico do Estado de São Paulo*, SABESP (Basic Sanitation Company of São Paulo State), *Saneamento de Goiás*, SANEAGO (Sanitation of Goiás), *Companhia de Saneamento do Paraná*, SANEPAR (Sanitation Company of Paraná), *Companhia de Saneamento do Estado do Mato Grosso do Sul*, SANESUL (Sanitation Company of Mato Grosso do Sul State) and *Companhia de Saneamento do Estado do Mato Grosso*, SANEMAT (Sanitation Company of Mato Grosso State).

- Paraguay

In Paraguay, the *Corporación de Obras Sanitarias,* CORPOSANA (Sanitary Works Corporation) provides services in Asunción Metropolitan Area, supplying treated water in compliance with Pan-American Health Organisation (PAHO) / World Health Organisation (WHO) standards. The urban population has a relatively better service in terms of quality; access to safe water is much lower in rural areas (Texeira *et al.*, 2000).

The *Servicio Nacional de Saneamiento Ambiental,* SENASA (National Environmental Sanitation Service) is the technical sanitation institution of the *Ministerio de Salud Pública y Bienestar Social*, MSPBS (Ministry of Public Health and Social Welfare), created by Law Nr 369/72. It is also the administrative authority of the *Código Sanitario* (Sanitation Code). SENASA's responsibilities comprise planning, promotion and supervision of environmental sanitation programs, drinking water supply, solid waste and excreta disposal, food control, occupational safety and hygiene and sanitary sewerage. For drinking water supply, it encourages the creation of Sanitation Boards in urban areas with less than 4,000 inhabitants and in the scattered rural populations (Texeira *et al.*, 2000).

The *Empresa de Servicios Sanitarios del Paraguay*, ESSAP (Sanitary Service Company of Paraguay) is in charge of water supply and sewerage services, including water withdrawal and treatment and excreta collection and treatment. Finally, the *Ente Regulador de Servicios Sanitarios del Paraguay*, ERSSAN (Sanitary Service Regulatory Agency of Paraguay), which depends on the Executive Power, regulates service provision, supervises the quality and efficiency level of the service and monitors the proper implementation of regulations in force (Monte Domecq, 2004).

- Uruguay

In Uruguay, drinking water coverage through *Obras Sanitarias del Estado,* OSE (State Sanitary Works) networks is very extensive, even in small towns. There is no intermittent supply resulting in the emptying of the distribution network, which would cause serious hygiene problems since water would be in danger of being contaminated. Water supply from superficial sources undergoes conventional treatment by means of coagulation, sedimentation, filtration and chlorination, while maintenance of adequate residual chlorine levels in the networks is monitored in compliance with standards. In case of supply from groundwater sources, treatment is limited to chlorination (Gobierno de la República Oriental del Uruguay, 2001).

The *Código de Aguas* (Waters Code) empowers OSE to monitor water bodies used as supply sources. OSE has created a work team in charge of following-up on raw waters quality from supply sources, by means of periodic sampling and mitigating measures programmes, to improve watercourses with adverse conditions. As for groundwater, exploitation of numerous wells has been stopped after detecting an excessive concentration of some substances –mainly nitrates and fluorine–, which would require highly expensive treatments for its distribution (Gobierno de la República Oriental del Uruguay, 2001).

The quality of effluents is ruled in accordance with the *Normas de Calidad de las Aguas Potables* by OSE of June 1986 (OSE Drinking Water Quality Standards) based on the guidelines set by the PAHO-WHO in 1985 (which were being revised in 2001). Special care is taken for processes quality by means of periodic monitoring of the water treatment plants after each treatment stage. Treatment is carried out by means of chlorine gas in plants that supply more than 10,000 inhabitants and with sodium hypochlorite in the remaining plants (Gobierno de la República Oriental del Uruguay, 2001).

As regards water treatment, it is estimated that 76.9% of the total volume of wastewater collected by the sewerage systems is treated effectively throughout the country. In Montevideo, the conclusion of the *Plan Director de Saneamiento* (Sanitation Master Plan) and the implementation of priority works (*Plan de Saneamiento de la ciudad de Montevideo - Etapa III*; Sanitation Plan of the city of Montevideo - Stage III), marked the beginning of a new era in the field of service planning (Salvatella Agrelo, 2000).

Sanitation services in the rest of the country are in charge of OSE, which in general makes specific repairs: also, preventive maintenance works on networks have been implemented since 1994. In the last 10 years, through programs financed by foreign aid (IDB, FONPLATA) and OSE funds, new treatment plants have been designed for major cities, with special attention on the protection of receptive watercourses. That derived in the construction of plants with diverse technologies: pre treatment and duct, secondary treatment (stabilisation lagoons, aerated ponds, sludge digested with different air systems, oxidation ditches) and a third treatment plant (digested sludge followed by chemical treatment aimed at reducing phosphorus and nitrogen) (Salvatella Agrelo, 2000).

Tables 5.2 and 5.3 summarise the main characteristics of water quality surveillance (Table 5.2) and service quality (Table 5.3) for the countries of the basin.

Table 5.2. La Plata River Basin. Characteristics of water quality surveillance by country - Summary

Aspects		Argentina	Bolivia	Brazil	Paraguay
National quality standards in force	**Yes**	■	■	■	■
	No				
National standards vs WHO guidelines	**Same**	■		■	
	Less efective		■		■
Drinking water control in urban areas	**Effective**	■		■	
	Not effective		■		■
Drinking water control in rural areas	**Effective**	■	■	■	■
	Not effective				

Note: Uruguay did not provide information about these items.
Source: CEPIS-OPS, 2000.

Tabla 5.3. La Plata River Basin. Service quality by country – summary

Aspects		Argentina	Bolivia	Brazil	Paraguay	Uruguay
Drinking water	**Intermittent urban systems**	n/d	n/d	n/d	30%	0%
	Urban systems with disinfection	90%	26%	n/d	100%	100%
	Operating rural systems	100%	95%	n/d	98%	6%
Wastewaters	**Volume treated**	10%	30%	10%	8%	76,9%

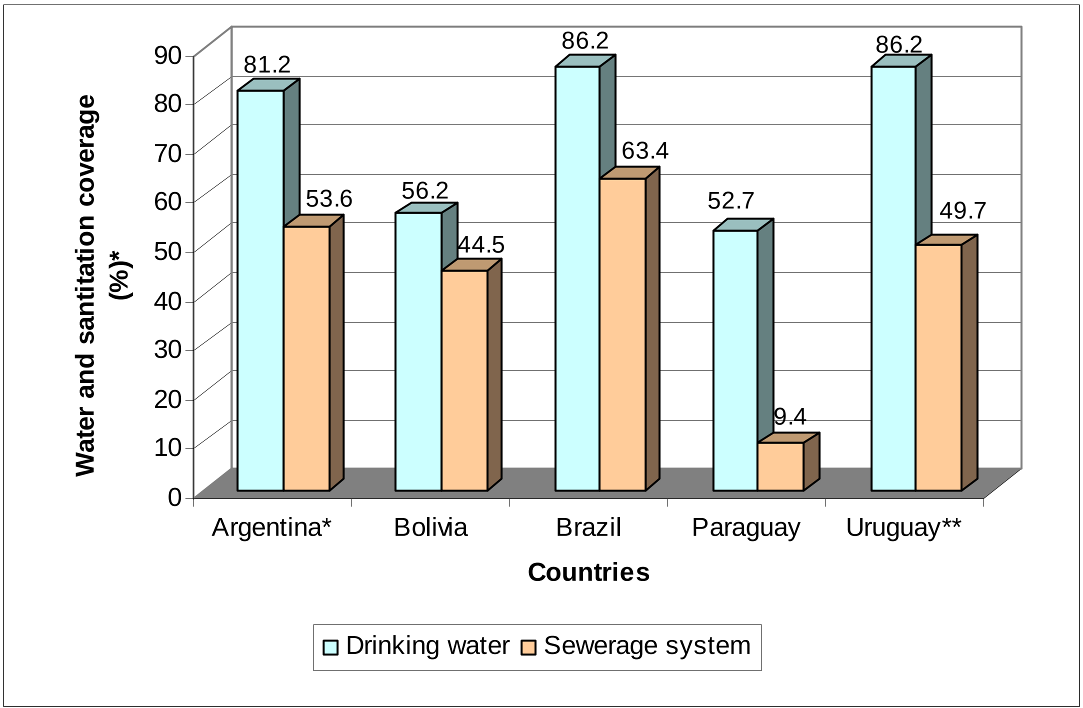
Note: n/d, no data
Source: CEPIS-OPS, 2000

5.4. Basic Services

5.4.1. Drinking and sewerage systems coverage in the La Plata Basin

Percentages of households with connections to drinking and sewerage systems (Figure 5.2) are using to indicate the coverage of both services in the La Plata Basin.

Figure 5.2. La Plata River Basin. Drinking and sewerage system coverage by country (last registered data)



Note: Data corresponding to Argentinean provinces (Census 2001), Bolivian departments (Census 2001), Brazilian states (Census 2000) and Uruguayan departments (Census 1996) included in the La Plata Basin.
* Percentage over total households; ** Sewerage system percentage over total households
Source: INDEC, 2001; INE, 2001 a; IBGE, 2000; DGEEC, 2002; INE, 1996

According to the Figure, coverage shows critical levels of deficiencies in the case of sewerage systems, reaching extremely low values, as is the case for Paraguay. As regards water networks, coverage percentages are higher although Paraguay and Bolivia show a low percentage of households supplied with the service. Forecast projection made in the beginning of 2000 show that all these percentages should be increased in year 2010. Table 5.5 summarises future coverage estimations.

Table 5.4. La Plata River Basin. Summary of drinking water and sanitation coverage projections by country

Aspects		Argentina	Bolivia	Brazil	Paraguay
Service coverage goals (water and sanitation)		Existing (partially)	Existing	Existing	Existing (partially)
Goals as at 2010 (population with access to service -in thousands-)	**Urban drinking water**	n/d	5,524	147,471	1,765.8
	Urban sewerage	n/d	4,603	147,471	2,600
Goals as at 2010 (population with access to service -in	**Urban drinking water**	n/d	162,788	1153.4	n/d

Aspects		Argentina	Bolivia	Brazil	Paraguay
thousands-)	**Urban sewerage**	n/d	162,788	1,800	n/d
National Programme for drinking water and sanitation		Not planned	Concluded	Concluded in 1995	Under construction

Note: n/d, no data. Uruguay did not provide information about these items.
Source: CEPIS-OPS, 2000.

In Argentina, projections for year 2005, drawn from the targets set in the various concession contracts, would indicate that 95% of the urban population could access network drinking water services, 65% would rely on a sewerage system for excreta dumping and 57% of collected sewage liquids would undergo treatment before ultimate disposal. On the other hand, it would expect that 32% of the rural population would have access to network drinking water services and that 53% would have access to a nearby reliable water source. Only 10% of this population would count on network excreta dumping systems, 43% would have adequate facilities and the rest would have to make use of individual systems of little reliability (Castro, 2000).

However, these targets had been set in times of crises by the end of the 90's. Therefore, a contract review process was started, opening a strong process of renegotiation to set real parameters and targets aimed at establishing not only operating improvements to the services, but also increased levels of coverage. Until 2000, no definite agreement has been reached, since there are a number of stakeholders involved in the negotiations, who naturally act to defend their own interests (Castro, 2000).

In Bolivia, preliminary forecasts expected for year 2010 result from the *Plan Nacional de Saneamiento 2000* (National Plan of Sanitation 2000). It is estimated that by year 2010 the population of Bolivia will amount to more than 10 million inhabitants out of whom 60% would account for urban population and 40% for rural. Therefore, in general terms, water coverage is expected to top 80% while sanitation is expected to reach 65% approximately (Orozco *et al.*, 2000).

In Brazil, the target of the National Sanitation Policy is to universalise the water supply and sewerage service for all the population by year 2010. To achieve this goal, it is estimated that an investment amounting to 0.38% of the GDP will be needed, at 1998 price rates (Fonseca & Medeiros da Silva, 2000).

Finally, in Uruguay, equally substantial investments are estimated necessary to improve sanitary sewerage system coverage and wastewater treatment (Salvatella Agrelo, 2000).

5.4.2. Affordability of water services

5.4.2.1. Provisions for the poor and minorities

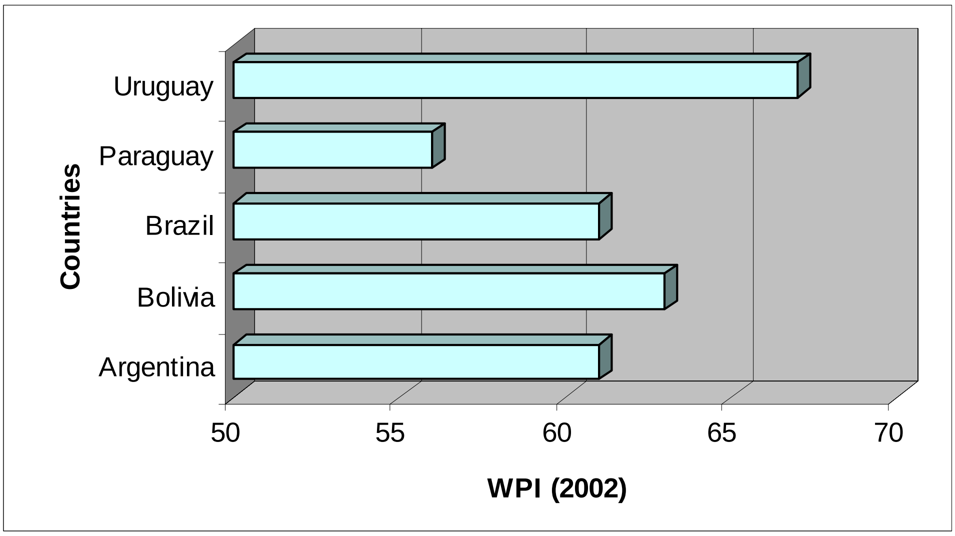
The situation of the poorest sectors of society as regards water supply could be expressed by the Water Poverty Index (WPI)[18], which is calculated by country using the data collected in

[18] The WPI measures the impact of water scarcity and water supply on human population in a given country. WPI comprises the following five component indexes: Resources, Access, Capacity, Use and Environment. Each

2002. Table 3.7 shows that WPI values vary between 56 (Paraguay) and 67 (Uruguay). The highest values represent a greater relative situation in terms of water supply.

The WPI is also used to draw comparisons between countries at a global level so as to get a general picture of water supply service shortages. To be able to draw these comparisons, WPI values are classified into six ranges. According to this classification (see Table 3.7), the La Plata Basin countries rank among those countries with high (Paraguay), medium (Argentina, Brazil) and medium-low (Bolivia, Uruguay) ranges.

Figura 5.3.. La Plata River Basin. Water Poverty Index by country (2002)



Note: WPI classification: Severe, WPI 35-47.9; High, WPI 48-55.9; Medium, WPI 56-61.9; Medium-low, WPI 62-67.9; Low, WPI 68-78.
Source: Lawrence *et al*, 2002.

In view of this scenario of shortages in terms of water and sanitation services available to the poorest sectors of society, the governments of the riparian countries are carrying out a number of strategies in order to lessen these shortages and, at the same time, reach two of the targets set in the Millennium Goals[19]. A description of the strategies carried out by each country is shown below.

- Argentina

In the 1990's numerous programmes and projects were created, with international financial aid, aimed at the institutional strengthening of provincial and municipal regulatory water agencies, identifying needs and technical solutions, financing investments for the expansion of sewer and drinking water services and improving the urban habitat. In spite that there was

component index is made up of sub-indexes. WPI is a number between 0 and 100, where a low score indicates water poverty and a high score indicates good water supply. WPI is the culmination of an interdisciplinary approach that combines both the physical quantities relating to water availability and the socio-economic factors relating to poverty to produce an indicator that addresses the diverse factors affecting resource management (Lawrence *et al.*, 2002).

[19] The targets are: reduce by 2/3 the population with no access to drinking water between 1990 and 2015 and reduce by 2/3 the population with no access to basic sanitation services between 1990 and 2015. Both targets are included in Objective 8, ensure a sustainable environment.

no global diagnosis on the results of the initiatives at the end of 2005, it is certain that the works have impacted on the basic sanitation services coverage. At any rate, since the areas without coverage are, in general, poor sectors of lower paying capacity, privatised companies that were granted the license to provide services are not encouraged to invest in the major urban areas of the country. Meanwhile, the State plays a regulatory and monitoring role and seeks financing for the development of new networks in small towns, which decreased dramatically as a result of the national and provincial fiscal crisis (Presidencia de la Nación Argentina, 2003 b).

In 2003, the government has reoriented resources towards the extension of networks and construction of water purification and treatment plants within the framework of the National Public Works Plan (Presidencia de la Nación Argentina, 2003 b). Among the concluded and ongoing programs and projects are:

- *Plan Agua Más Trabajo ("Water plus jobs" Plan)*: this plan, under the responsibility of the *Ente Nacional de Obras Hídricas de Saneamiento,* ENOHSA (National Agency of Water Works for Sanitation) builds drinking water networks through cooperatives of unemployed people who were granted a *"Plan Jefes y Jefas de Hogar"* (Heads of Household Plan[20]). This plan is being implemented both in the Buenos Aires Metropolitan Area and in the interior of the country (Secretaría de Obras Públicas de la Nación, 2005).

- *Programa Tarifa Social ("Social Tariff" Programme):* This program is managed by the *Ente Tripartito de Obras y Servicios Sanitarios,* ETOSS (Tripartite Agency of Sanitary Works and Services), aimed at the population below poverty line and non-profit organisations which provide direct social and/or health assistance to poor population. Basically, it consists in granting a subsidy by means of discount modules applied to the invoicing of the service of those selected for this benefit. The Programme is implemented in areas where *Aguas Argentinas*[21] provides its services (Buenos Aires City and 17 municipal districts in the Buenos Aires Metropolitan Area) (ETOSS, 2005).

- *Programa Barrios Carenciados ("Poor Neighbourhoods" Programme):* Also implemented by ETOSS in order to achieve the extension or the technical-commercial regularisation of the services in slums and shanty towns (called "villas de emergencia") based on the concept of communal participation. It is an agreement between the service company, which provides input and materials, the neighbours, who contribute with their labour, and municipal governments, which provide all necessary logistics and machinery. The beneficiaries of the plan are the inhabitants of poor neighbourhoods, with shanty or low-cost housings and an inexistent or irregular urban plot[22], which totals a population of up to 2,500,000 people (ETOSS, 2005).

[20] The aim of the *Plan Jefas y Jefes de Hogar* is to provide financial aid to unemployed heads of households, wh should, in turn, work in consideration.
[21] Aguas Argentinas is the private concessionary company which provides water supply and sanitation service in this area since 1993. The company replaced *Obras Sanitarias de la Nación* (Sanitation Works of the Nation).
[22] This classification comprises shanty towns with an irregulary or inexistent urban plot, precarious neighbourhoods with regular urban plots or neighbourhoods with government-built households.

- Bolivia

The coverage of basic services in Bolivia has improved substantially in the early 2000's, as compared to the previous decade. However, in spite of these advances, the government deems it rather unlikely to fulfil the Millennium Goals in this sector, mainly due to the lack of enforcement of regulations or laws and the institutional weakness to do so (UDAPE-INE-Sistema de las Naciones Unidas en Bolivia, 2002).

With regard to the particular scenario of poor sectors and minorities, the government has launched the following plans and programmes:

- *Estrategia Boliviana de Reducción de la Pobreza, EBRP (Bolivian Strategy for Poverty Reduction)*: Among its national priorities in basic sanitation are: drinking water supply, sanitary sewerage, excreta dumping and collection of solid wastes, mainly to the poorest population. The proposed actions are the construction of water and sewerage systems in periurban and rural areas, the construction of sewage water treatment plants and the development of programmes for the strengthening of the *Viceministerio de Servicios Básicos* (Vice Ministry of Basic Services) (Gobierno de la República de Bolivia, 2001).

- *Plan Decenal de Saneamiento Básico (Basic Sanitation Decennial Plan):* This programme is focused on the systematic development of the sector between 2001 and 2010. In order to supply poor sectors, a joint effort by the central government and local governments is expected through the so-called *Política Nacional de Compensación,* PNC (National Policy of Compensation), with the aim of taking action towards the struggle against poverty. In specific terms, the PNC grants subsidies to the poorest sectors and the demand for a lower financial counterpart to the poorest municipal areas (Viceministerio de Servicios Básicos de Bolivia, 2001).

Other projects include components and objectives connected with the struggle against poverty. Among these are the following: *Programa de Inversiones en el sector Saneamiento* (Programme for Investment in Sanitation), *Programa de Apoyo a la Salud e Higiene de Bolivia* (Programme for Health and Hygiene Support of Bolivia), in the departments of Tarija and Potosí (Basic Sanitary component), the *Programa Subregional Andino de Servicios Básicos contra la Pobreza*, PROANDES (Andean Subregional Programme for Basic Services against Poverty) and the *Programa de Rehabilitación de las Redes de Agua Potable y de Saneamiento* (Programme for the Restoration of Drinking Water and Sanitation Networks) in Santa Cruz de la Sierra City (Viceministerio de Servicios Básicos de Bolivia, 2006).

- Brazil

Efforts by the Brazilian government to revert the general basic sanitation scenario were limited by the economic and financial crisis during the 90's, which led to oscillations in the sector's annual average investment. As of 2003, the sector saw recovery prospects and started to get priority attention from the government (Governo da Republica Federativa do Brasil, 2004).

Metropolitan areas of the country are considered as a priority within the universe of population with deficient access to drinking water[23]. These big cities hold nearly 30% of inhabitants who live in houses deemed inappropriate. On the other hand, a percentage of 85% small municipalities have a population under 80,000 inhabitants and show sanitation services coverage rates lower to the national average standards (Governo da Republica Federativa do Brasil, 2004).

The *Secretaría Nacional de Saneamento Ambiental* (National Secretary of Environmental Sanitation), depending upon the *Ministerio das Cidades* (Ministry of the Cities), has been carrying out the following programmes and projects specifically aimed at the population with scarce resources:

- *Programa de Ação Social em Saneamento, PASS / IDB (Programme for Social Action in Sanitation)*: Its target is to universalise the drinking water supply and sewerage services in urban areas which concentrate the greatest poverty, while improving the health context of the population and its environmental conditions. The programme is restricted to small and medium sized municipalities with greater deficits in service coverage; these are poor districts in the North, Northeast and Centre-west regions. In addition to the supply and/or extension of the service, the Programme provides for actions towards sanitary and environmental education, training by environmental organisations, improvement of management and endorsement of studies carried out in order to develop policies in the sanitation area (Secretaria de Saneamento Ambiental, 2005).

- *"PAT Prosanear – Programa de Urbanização de Favelas e Saneamento Integrado em Areas de Baixa Renda (Programme for the Urbanisation of Shanty Towns and Integrated Sanitation in Low-income Areas)*: This is an initiative by the federal government focused on providing technical and financial support to Brazilian municipalities with less than 75,000 inhabitants, in making sustainable plans and projects in shanty towns (know locally as *favelas*) and low-income areas. This programme finances the drawing up of urban development plans and integral sanitation projects. It also supports training, institutional and human resources development, and social strengthening activities (Secretaría de Saneamiento Ambiental, 2005).

- <u>Paraguay</u>

Paraguay suffers serious problems in terms of water supply and sanitation although an increase in coverage was recorded between 1992 and 2005. The greatest differences in terms of deficiencies are between urban and rural areas and between poor and non-poor sectors. According to the trend, it is considered that a substantial improvement in the access to drinking water is not likely to be achieved (Sistema de las Naciones Unidas en Paraguay, 2003).

In connection with programmes aimed at meeting the needs of disadvantaged populations, no updated information has been found at the end of 2005. It is known that the *Ministerio de Justicia y Trabajo* (Ministry of Justice and Labour) has coordinated the Programme

[23] Three major cities located in La Plata Basin (São Paulo, Curitiba and Brasilia) are included among these prioritary areas. The remaining ones are Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Rio de Janeiro, Porto Alegre and Manaus.

"Oñondivepá" in the struggle against poverty. It was an initiative by the government's *Secretaría de Acción Social* (Secretary of Social Actions) that intended to coordinate efforts with CORPOSANA and SENASA to meet the demands of the poorest populations and encouraged the social harmonisation process within the local environment to revert the extreme poverty in which a great percentage of the population is immersed. The programme suggested not only an increase in effective social expenses, but also the rationalisation of existing public resources. In the short-term, it intended to provide basic infrastructure and social services. Until September 1999, a series of activities were performed in the departments of Concepción, Ñeembucú and San Pedro and the second phase of the programme in the departments of Caazapá, Canendiyú and Misiones was being carried out in 2000 (Texeira *et al.*, 2000).

- Uruguay

Between 1991 and 2000 improvements have been observed in terms of drinking water supply, mainly in urban areas. Therefore, the government estimates that the fulfilment of the development goals is not in jeopardy, at least in this aspect. However, the sanitation service behaves differently. It requires high densities of population to make the extension or creation of networks viable. This contrast with the way urban peripheral areas grow, where the most disadvantaged population is concentrated. The same occurs in smaller urban centres and rural areas (Sistema de las Naciones Unidas en Uruguay, 2003).

OSE –which supplies drinking water to the whole country except Montevideo– has started a long-term planning cycle of water and sanitation systems, by means of modernising the system both technological and institutionally. The goal is to increase investment in improving existing systems and extending them to new areas, so as to improve territorial coverage (Sistema de las Naciones Unidas en Uruguay, 2003).

The Departmental Government of Montevideo has drawn up the *Plan Director de Saneamiento* (Master Plan of Sanitation) in the early 1990's, which has resulted in a significant increase in network coverage in popular peripheral areas of the country's capital city (Sistema de las Naciones Unidas en Uruguay, 2003).

The government has been implementing the following programmes and projects aimed at the population with scarce resources:

- *Programa de Integración de Asentamientos Irregulares, PIAI (Programme for the Integration of Irregular Settlements)*: The aim of this programme is to improve the life quality of individuals living in irregular settlements, promoting their physical and social integration to their urban surroundings. The resources of the programme are allocated to financing projects and activities coordinated by interdisciplinary technical teams at a neighbourhood level. Among the eligible projects are the construction and/or extension of drinking water local networks, household connections and connections to existing networks (Presidencia de la República Oriental del Uruguay, 2005).

- *Plan de Atención Nacional a la Emergencia Social, PANES (Plan for National Care of Social Emergency)*: This plan has been launched in March 2005 and its goal is to deal with all measures conducive to meeting unsatisfied basic needs of the population below poverty line. Although the main focus of attention is covering food and health necessities, the plan also contemplates the struggle against the proliferation of precarious settlements and the lack of sanitary coverage. It comprises a number of programmes that are, in turn, articulated with other projects developed by the government, such as the PIAI (Ministerio de Desarrollo Social de la República Oriental del Uruguay, 2005).

5.5. Water related diseases

Major water-borne diseases in the La Plata Basin are diarrhoea, malaria, dengue and cholera. Other diseases of relative less importance are yellow fever, leptospirosis and leishmaniasis. Table 5.5 shows the recorded cases of water-borne diseases between 1998 and 2005 in the five riparian countries.

Table 5.5. La Plata River Basin. Cases of water-borne diseases by country (between 1998 and 2005)

	Argentina	**Bolivia**	**Brazil***	**Paraguay**	**Uruguay**
Diarrhoea	951,480 (2003)	315,786 (2005)	260,000 (2002)	41,450 (1999)	n/d
Cholera	12 (1998)	467 (1998)	753 (2000)	4 (1996)	---
Malaria	122 (2003)	23,552 (2005)	5,514 (2003)	1,392 (2003)	90 (2003)
Dengue	135 (2003)	4,095 (2005)	21,913 (2004)	148 (2005)	---
Leptospirosis	201 (2004)	n/d	1,353 (2003)	n/d	20 (2002)
Leishmaniasis	748 (2002)	1,735 (2000)	7,633 (2003)	86 (2004)	---
Yellow fever	---	56 (2005)	62 (2003)	---	---

Notes: * Data for states of the La Plata Basin; n/d, no data; ---, no cases recorded.
Sources: PAHO, 2004 a; Ministerio de Salud y Ambiente de la Nación-OPS, 2005; Sistema Nacional de Vigilancia Epidemiológica de Argentina, 2003; Sistema Nacional de Información en Salud de Bolivia, 2005; Ministerio da Saúde, 2004; Ministerio de Salud Pública y Bienestar Social del Paraguay, 2005, Ministerio de Salud Pública de la República Oriental del Uruguay, 2002.

Cholera epidemics occurred in the basin in the 1990s, except in Uruguay. This is the only country where water-borne diseases have not impacted greatly up to 2005. Diarrhoea mainly affects children under 5 years of age. Schistosomiasis shows a wide geographical distribution in Brazil, affecting the Northeast of the country and the North of the State of Minas Gerais. Also, foci of this disease were found in the States of São Paulo, Rio Grande do Sul, Goias and Distrito Federal (Dias Coelho, 2004).

The following paragraphs summarise the incidence of each water-related disease in the basin.

- Diarrhoea

This is the most frequent water-borne disease in Argentina, with an incidence of up to 0.067 cases per year in children under 5 years of age (Castro, 2000). In Paraguay, it was the third leading cause of outpatient consultations in health services of the *Ministerio de Salud Pública y Acción Social* (Ministry of Public Health and Social Welfare). The mortality rate for acute diarrhoeal disease (ADD) in the general population was 8.3 per 100,000 in 1996 and 6.4 per 100,000 in 1999. ADD was the second leading cause of death in children aged 1 to 4 (15% of all deaths in that age group) (PAHO, 2004 a).

- Cholera

The regional cholera epidemic of the 1990s affected Argentina, Bolivia, Brazil and Paraguay. In Argentina, most of the cases occurred in the northwest region and the case reports showed a seasonal epidemic pattern, according to which, the number of cases increases in the summer (PAHO, 2004 a). In Bolivia, incidence has declined since 1995, after a period of 814 deaths caused by cholera (PAHO, 2004 a). The same happened in Brazil, where the lowest number of cases was recorded in 2000 and in Paraguay, where no cases have been reported since 1997 (PAHO, 2004 a).

- Malaria

The disease is actively transmitted in 75% of the Bolivian territory (where half the country's population lives). It also has a great incidence in Brazil, where it is the major vector in the Amazonian states. In some Brazilian states of the La Plata Basin, malaria cases have increased in the early 2000's (Secretaría de Vigilãncia em Saúde, 2005 b). In Paraguay, an important epidemic was detected in the early 2000's. In Argentina, malaria occurred most frequently in risk areas in the province of Salta, bordering Bolivia. In the Northeast, some occasional epidemic episodes were reported (PAHO, 2004 b).

- Dengue

Brazil shows a relatively worse situation regarding dengue fever. Nevertheless, in the first six months of 2005 incidence has decreased by 28.5% compared with 2004 (Secretaría de Vigilãncia em Saúde, 2005 a).

In Argentina, the vector has been detected in 17 of the 24 provinces of the country. During the first three months of year 2000 cases of classical dengue fever reappeared in the indigenous communities located in the Northwest. During the summers of 2000 and 2001, no epidemic outbreaks were reported. However, isolated cases –imported from neighbouring countries– continued to be reported.

The re-emergence of dengue was detected in Salta in 1997, where an outbreak of dengue fever type 2 occurred later in 1998. During 2000 a dengue type 1 outbreak in the Northeast of Argentina was reported, specifically in Misiones and Formosa provinces. In 2001 no autochthonous transmission was detected and in 2002 and cases of dengue type 1 were reported in Salta Province. Autochthonous transmission was detected in Misiones, Formosa, Jujuy and Salta provinces. Other jurisdictions of the country have reported imported sporadic cases.

In spite of the fluent traffic of population across the borders, climate factors favouring the vector's proliferation, viral circulation of serotype III in bordering populations of Bolivia, Paraguay and Brazil, outbreaks in neighbouring populations such as Foz do Iguaçú (Brazil), it was possible to prevent autochthonous cases in border areas and control the outbreak in Salta. Dengue serotype III first appeared in an imported case in Misiones Province in 2002 (Dirección de Epidemiología de la República Argentina, 2002).

In Bolivia, classic cases of dengue have been documented since 1987. In 1999, 27 cases of classic dengue were identified and in 2000, 80 cases were reported. In 2003 almost 1,500 suspected cases were registered and 128 were confirmed (OPS, 2003).

Dengue transmission was detected in February 1999 in Paraguay, and an epidemic ensued, affecting a large part of the country. The country undertook an intensive campaign to combat the epidemic, enlisting the participation of institutions and organised community groups. Nevertheless, many Paraguayan cities still have indexes of *Aedes* that are compatible with transmission of dengue (PAHO, 2004 b).

Although there is no autochthonous transmission of dengue in Uruguay, a potential problem has been posed since the reintroduction of the *Aedes aegypti* mosquito, which may transmit dengue (PAHO, 2004 a), mainly in the cities of Fray Bentos and Mercedes (PAHO, 2004 b). In 2002, 11 cases of dengue were registered throughout the country, all of which were travellers who had been in Brazil 15 days prior to the onset of the symptoms. If the number of households surveyed is compared with the number of positive cases, it is observed that, although the rates are kept low, the vector is increasingly expanding in the territory, which makes the fight against the disease both difficult and expensive (OPS, 2003).

- Leishmaniasis

In Argentina, the endemic area of this disease comprises the Northern provinces, which are either totally or partially included in the La Plata Basin: Salta, Jujuy, Tucumán, Formosa, Chaco, Santiago del Estero, Misiones and Corrientes. In 1998 over 1,000 cases were reported, most of which caused by an epidemic outbreak in Salta and Misiones. Since then, a significant decrease in the number of cases was observed until 2001, when 144 cases were reported, 84% of which were detected in Chaco, Salta and Misiones provinces. In 2002, another outbreak of the disease was recorded, claiming 748 cases, with foci along the Bermejo River Basin and its influence area. Salta, Formosa, Chaco and Jujuy reported 96% of all cases recorded in 2002 throughout the country (Dirección de Epidemiología de la República Argentina, 2002).

In Brazil, the American tegumental leishmaniasis has expanded its contagion area as compared to previous years when it was restricted to Amazonian states. At 2004, all the states of the Federation present autochthonous cases of the disease. According to the *Ministério da Saúde* (Ministry of Health), this may be due to difficulties met in controlling the disease because of the constant changes in vectors and epidemiologic patterns of transmission, mainly associated with the human action on nature (Secretaria de Vigilância em Saúde, 2004).

- Leptospirosis

In 2001, 175 cases were reported in Argentina, which shows an increase of over 200% as compared to the previous year[24]. Most of the cases (89%) were recorded in Buenos Aires Province, 36% in Santa Fe Province and the remaining 13% distributed in the provinces of Entre Ríos, Misiones, Córdoba, La Rioja and Jujuy provinces (Dirección de Epidemiología de la República Argentina, 2002).

In Brazil, an annual average of 3,324 cases was recorded between 1994 and 2003, with an average case-specific mortality topping 10%. The most affected age group is adults between 20 and 49 years of age and most cases are associated with poor living conditions and lack of sanitary infrastructure, mainly in the household. The disease appears both in urban and rural areas. However, most reported cases are focused in capital cities and metropolitan regions. Floods and heavy rains make human contact with water contaminated by excreta of rodents more likely, thus favouring contagion (Secretaria de Vigilância em Saúde, 2004).

Between 1999 and 2002, there were around 120 suspected cases of leptospirosis in some departments in Eastern and Central regions of Uruguay, of which only 35 were confirmed. In addition, in 2002, the number of suspected cases increased (OPS, 2003).

In 2002, a few cases of this disease were reported in Montevideo Metropolitan Area, more precisely, in flood-stricken slums (Pignataro, 2002).

- Yellow fever

The urban form of this disease has disappeared in Brazil and only its wild form remains. Anyway, the presence of *Aedes aegypty* in the urban area of a great part of the territory poses potential threats to reintroduce urban yellow fever (OPS, 2003).

In the La Plata Basin, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul states are part of the disease's transition area, while the "unscathed area" comprises the South and Southeast regions, where there is no proven circulation of the virus. The last big epidemic affected Minas Gerais State in 2003 (Secretaria de Vigilância em Saúde, 2004).

Thanks to the progressive increase in vaccination, the incidence of yellow fever in Bolivia has decreased in 2003 versus previous years, mainly in the endemic areas of the disease (OPS, 2003).

In Paraguay, the disease had practically disappeared. However, in view of the cases reported in Bolivia, a series of preventive measures were taken to avoid the reintroduction of the disease (OPS, 2003).

5.6. Health Policy and Legislation

5.6.1. General characteristics

[24] The source pointed out that it is necessary to investigate in order to determine whether or not cases had been under-reported prior to year 2001 or if there was a real increase in the transmission of the disease during that year (Dirección de Epidemiología de la República Argentina, 2002).

The health national ministries are in charge of defining political and strategic guidelines for the sector in all five countries of the basin. Generally, the goals of these programmes are similar because all of these seek to guarantee access to health for everyone, focusing on the highest risk groups (children, the elderly, indigenous communities) and encourage health promotion and prevention.

In Argentina, the *Ministerio de Salud*, MSAL (Ministry of Health) has taken a commitment with entities in the health sector within the framework of the *"Mesa del Diálogo"* (Dialogue Table), in which a number of objectives are set towards improving coverage and health quality. Among said objectives, the following strategies and actions are worth highlighting:

- Reduce sanitation and epidemiologic risks of the population as a whole, especially among the most vulnerable groups.
- Improve accessibility to health services.
- Define adequate tools to solve sanitary emergency (Ministerio de Salud y Ambiente de la Nación Argentina, 2002).

In Bolivia, the central goal of the *Ministerio de Salud y Deportes*, MSP (Ministry of Health and Sports) is to consolidate health as a right without fragmenting problems or isolating them from their social context. It intends to encourage promotion, prevention and healing within an atmosphere of integrity, bearing in mind that defending health requires not only specific medical action but also deep social changes. In this context, the creation of the *Sistema Nacional de Salud* (National System on Health) provides for the rationalisation and optimisation of Primary Health Care resources, one of which is basic sanitation (Ministerio de Salud y Deportes de la República de Bolivia, 2005 a).

In Brazil, the national health policy is based on the Federal Constitution of 1988, which sets out the principles and guidelines for the delivery of health care in the country through the *Sistema Unico de Saúde,* SUS (Unified Health System). Under the Constitution, the activities of the federal government are based on multiyear plans approved by the National Congress for four-year periods. The main goals of the health sector are the improvement of the overall health situation, with emphasis on reducing child mortality rates, and a political-institutional reorganisation of the sector, with a view to enhancing the operating capacity of the SUS (PAHO, 2004 b). These goals were included in the new *Plano Nacional de Saúde - Um Pacto pela Saúde no Brasil,* PNS (Health National Programme – A Pact for Health in Brazil) approved in December 2004. Besides, this plan promotes:

- strengthening the management of the *Sistema Nacional de Vigilância em Saúde* (National Health Surveillance System), in all three branches of the government, in the areas of epidemiologic, sanitary and environmental surveillance, in order to broaden its capacity to analyse health situations and respond to the needs of the population;
- reduce morbidity and mortality caused by diseases and their consequent problems by means of intensifying individual and collective preventive and curative actions, taking into consideration both local and regional diversities as well as those groups or segments of the population that are most exposed (Ministerio da Saude, 2004).

On the other hand, the experience of the *Fundação Nacional de Saúde,* FUNASA (National Health Foundation) clearly integrates basic services supply and health care. This task is done in coordination with the municipalities in order to develop health and sanitation coverage in the interior of the country. To start this project, *Serviço Autônomo de Água e Esgoto*, SAAEs

(Water and Sewerage Autonomous Services) were created, which are institutions independent from the municipalities, both at an administrative and financial level.

In Paraguay, the National Constitution of 1992 states that health is a fundamental right and entrusts the State with its protection and promotion in the interest of the community (PAHO, 2004 a). The *Ministerio de Salud Pública y Bienestar Social* (Ministry of Public Health and Social Welfare) has been developing a series of sanitation programmes, including general public services, public health, environmental sanitation, eradication of vectors, science and technology. It is also the authority of the Sanitary Code (Monte Domecq, 2004).

In 2003, the national government has defined the so-called National Health Programme for 2004-2008. The following are some of the goals set by the programme (Ministerio de Salud Pública y Bienestar Social del Paraguay, 2003):

- decrease mother-infant mortality and morbidity rates;
- facilitate access to quality health services to disadvantaged populations;
- prevent and control environmental risks;
- increase epidemiologic surveillance in order to ensure control and prevention of prevalent, emerging and re-emerging diseases, avoiding the outbreak of new diseases;
- decrease prevalence and incidence of chronic and degenerative diseases; and
- improve care in health services.

In Uruguay, the *Ministerio de Salud Pública* (Ministry of Public Health) established five major goals for 2000-2005:

- strengthen the management of public and private health care institutions.
- adapt the supply of available services to the epidemiological characteristics and needs of the population.
- make health care coverage universal by facilitating access and care at all four levels of complexity.
- enhance service quality at all four levels of complexity.
- rationalise the use of services at Institutes of Highly Specialised Medicine.
- promote participation of service users and health care institutions to be able to solve problems within an atmosphere of trust and respect for the rights of citizens (PAHO, 2004 b).

5.6.2. Specific programmes, projects and laws

Only partial information has been found about the implementation of programmes, projects and laws connected with prevention and control of water-borne diseases. A brief summary of these initiatives is provided below.

- International

Red de Vigilancia de las Enfermedades Emergentes y Reemergentes del Cono Sur (Southern Cone Surveillance Network of Emerging and Re-emerging Diseases): created in 1998 by the joint initiative of a number of countries, supported by cooperating agencies connected with this field. At the beginning, surveillance was based on the laboratory and, later, epidemiology was integrated, which broadened the knowledge of these diseases in the sub region (OPS, 2003).

Convenio de Cooperación en Materia de Salud Argentina-Uruguay (Cooperation Agreement on Health between Argentina and Uruguay): in which the epidemiologic surveillance of water-borne diseases is included.

- National

Programa Nacional de Controle da Dengue, Ministério da Saúde, Brasil (National Programme for Dengue Control, Health Ministry, Brazil): it has been carried out since July 2002. The aim is to reduce infections caused by *Aedes aegypti*, the incidence of dengue and mortality caused by dengue's haemorrhagic fever (Fundação Nacional da Saúde, 2002).

Programa Nacional de Prevenção e Controle da Malária, Ministério da Saúde, Brasil (National Programme for Malaria Prevention and Control, Health Ministry, Brazil): it has been operating since 2003. It is a continuation of past efforts to control the disease. Its main goal is to establish a permanent policy to prevent and control malaria. This Programme seeks to reduce incidence and deaths caused by malaria, an endemic disease in Brazil (Secretaria de Vigilância em Saúde, 2003).

Plano de Intensificação das Açoes de Prevenção e Controle da Febre Amarela, Ministério da Saúde, Brasil (Plan for the Intensification of Actions to Prevent and Control Yellow Fever, Health Ministry, Brazil): it has been working since 2001. Its main goal is to eradicate yellow fever in its wild form, since the urban form was eradicated by mid XX century[25]. One of the fundamental pillars is strengthening the epidemiologic surveillance in the country's states and municipalities (Secretaria de Vigilância em Saúde, 2005 c).

Plan de Acción Nacional contra la Fiebre Amarilla del Ministerio de Salud Púbica y Bienestar Social, Paraguay (National Action Plan against Yellow Fever, Ministry of Public Health and Social Welfare, Paraguay): implemented in 2001 in three different stages and by defining risk areas based on virus circulation in neighbouring countries (OPS, 2003).

[25] In spite the urban form of yellow fever was eradicated, there is still a potential risk of reintroduction.

Challenge: Water and Ecosystems

Overview: This challenge puts emphasis on ensuring the integrity of ecosystems through sustainable water resources management.

6. Water for ecosystems

6.1. Biological assessment of freshwater systems including coastal zones

The biological assessment of freshwater systems and coastal zones will be carried out for each one of the sub-basins of the La Plata River Basin: Paraná, Paraguay, Uruguay and those rivers directly flowing into the La Plata River.

6.1.1. Aquatic flora and fauna[26]

6.1.1.1. Rivers and coastal zones

- Paraná River

Biotic communities of the Paraná River have been undergoing considerable changes over the last fifty years, as a result of the large dams located mainly in the upper basin. Besides, since the programme of dam construction continues, constant negative changes are experimented as a result of the modifications introduced in the system. This situation makes difficult the study of biotic communities, since their variation might grow a lot and diversely throughout time. This effect is especially observed in the Upper Paraná (Argentina-Paraguay) and the Middle and Lower Paraná (Argentina) (Bonetto & Hurtado, 1998).

As regards phytoplankton, there is a remarkable group of algae in the Paraná River, both for its specific richness as well as for the population density in general. The dominant associations in different stretches of the river are very similar, of which the *Aulacosira* diatoms stand out. In the floodplain and interphase areas, the specific diversity and density can be very remarkable. Phytoplankton density in river samples –montly taken– seems to fluctuate between 50 and 2,550 ind/ml in front of Paraná City (km 601 of the river, in Entre Ríos Province). Downstream, density decreases considerably, although there are significant variations among different rivers and streams of the Paraná Delta (Bonetto & Hurtado, 1998).

Regarding zooplankton, the major density seems to be located in the Middle Paraná, with a predominance of rotifers of different genera. There might be differences in the importance of relative distribution in waters belonging to different banks, especially in the confluence with the major tributaries like the Paraguay River. Downstream from this confluence, the difference of population density and the specific richness can be significant (7 and 528 ind/l), whereas in alluvial plains density increases considerably to up to 1,000 ind/l in the lagoons associated to the Middle Paraná (Bonetto & Hurtado, 1998).

[26] The common names of aquatic and terrestrial organisms have been translated into English. However, some local common names have no possible translation; thus, original Spanish or Portuguese names were maintained. In all those cases, scientific names are given between brackets. In few cases, only scientific names appear.

Benthos has been hardly studied in the Upper Paraná. In the sandy stretches and from the East-West stretch of the Upper Paraná, there is a clear predominance of the *Narapa bonettoi* genus, together with some crustaceans and molluscs. In sandy rivers with scarce suspended solids, *N. Bonettoi* density may amount to 300,000 ind/m^2 –twofold the amount that can be found in the Middle Paraná–, as it happens in the Lower Paraguay (Bonetto & Hurtado, 1998).

One of the characteristics of this area's ichthyofauna is that it is composed of a scarce number of big fish categories, which contrasts with the extraordinary species richness (only in Argentina some 380 species have been estimated). Another characteristic aspect is the high predominance of Characoidei and Siluriform fishes, although there are, as well, other autochthonous stocks of marine origin, recently introduced into the continental aquatic medium. Also, this ichthyofauna shows significant endemism (Bonetto & Hurtado, 1998).

From the trophic viewpoint, the scarcity of strictly planktophagus fish proves to be important. On the other hand, it is worth highlighting the wide variety and the big size that ichthyophagous species inhabiting these rivers may reach, among which the Siluriforms of the genus Pseudoplatystoma (*P. coruscans* and *P. fasciatum*) and the "manguruyú" (*Paulicea lütkeni*) stand out. The most remarkable aspect of the ichthyofauna of the big rivers is the fundamental importance of detritivorous-iliophagous fish. Within this varied group, the species of the genus Prochilodus stand out, of which "sábalo" (*P. lineatus*) can provide on average more than half the ichthyomass recorded in the permanent lentic environments of the floodplain of the Middle Paraná. These are migratory species that must travel very long distances before finding an appropriate place for breeding (Bonetto & Hurtado, 1998).

Before the big damming works, the Upper Paraná had a remarkable fishing production and registered many of the most corpulent species of the highest fishery value in these waters. Within the latter, some Siluriforms such as *Pseudoplatystoma coruscans* and *P. lütkeni*, and the Characoidei (Cypriniforms) *S. maxillosus*, *Brycon orbignianus* and *Hoplias malabaricus* stand out, among others. Those projects have affected the rivers of the region considerably, not only for the profusion and magnitude of these works but also for the absence of fish ladders that allowed migratory species to be able to fulfil their vital functions, such as breeding (Bonetto & Hurtado, 1998).

In the rest of the Paraná River, problems of this kind are relatively less important, except for a few large dams built or scheduled for construction in the Upper Paraná –such as Yacyretá or Corpus Christi– and some of its tributaries. In fact, the ichthyofauna of the highest fishery value is found in the sections spanning from the Middle Paraná to the Paraguay River, and in the distal part of the Upper Paraná. In these stretches commercial and sport fishing is intense, which includes "surubíes" (*P. coruscans* and *P. fasciatum*), "manguruyú" (*P. lütkeni*) and "dorado" (*S. maxillosus*), a species that sustains important sports competitions and generates a significant international tourist movement. The most complex area in terms of fishery production is represented by the Middle and Lower Paraná, the Delta and the La Plata River. This area is mainly affected by one of the major demographic and industrial concentrations in the region (Bonetto & Hurtado, 1998), which, in the La Plata River, comprises the Buenos Aires Metropolitan Area (Argentina) and Montevideo (Uruguay).

Following is a description of the aquatic flora and fauna of the major international tributaries of the Paraná River, that is, the Paraguay and Iguazú rivers.

- Paraguay River

The Paraguay River Basin holds the Pantanal, which is considered the most important wetland in South America. In the Pantanal 263 fish species were recorded and more than 85% belongs to the order Ostariophysi. These fish adjust better to the dark water environments where they generally live. Fish such as “pacú” *(Piaractus mesopotamicus*), “dorado” *(Salminus maxillosus)*, “pintado” (*Psuedoplatystoma fasciatum*), etc, belong to this group (Dias Coelho, 2004).

The ichthyofauna plays a key role in the environmental balance. The big fishery stocks are one of the major live nutrient and energy reserves. Fish, among other functions, act as seed dispersers and are the basic food for many components of the fauna, even the ichthyofauna itself. The most important species for fishing are associated to the most floodable regions (Dias Coelho, 2004).

- *Iguazú River*

The waterfalls formed by the Iguazú River before its mouth, are its most singular feature. These waterfalls, that reach 70 to 80 meters in height, provide a practically impregnable wall for migratory fish, as a result of which the upper stretch presents an endemism phenomena not sufficiently studied yet.

The numerous falls of the waterfalls precipitate in a setting of majestic vegetation, with predominance of Podostemaceae, which provides the seat for the development of a very diverse and abundant aquatic biota. A remarkable richness of aquatic organisms can be detected in the vegetation and in the lateral brooks and stony grounds of the shallows. In this sense, the poripherous are remarkable, with many endemic and very abundant species. Molluscs have a varied and rich composition, both in quiet waters and in rapids. Insects are more abundant and perhaps more varied (Bonetto & Hurtado, 1998).

- Uruguay River

As regards phytoplankton, the existing studies are synoptic and lack enough information on population structure and density in the annual cycle. The highest density peaks take place in spring and summer, with some 37,000 ind/l. Apart from this low population density, there is also a restricted diversity, which could result from the absence of extensive floodplains like the ones found in the Middle Paraná (Bonetto & Hurtado, 1998).

Available information on the Uruguay River’s zooplankton is also quite scarce, with some 40 species recorded. Data on population density and diversity disclosed in the literature may seem to indicate that the low values shown would be normal and typical of the river. However, they could be a consequence of negative factors resulting from the anthropic influence, such as, for example, the eutrophication or excessive pollution of the waters.

Information on benthos is more complete, at least as regards some ecological parameters (characteristics of the bottom, flow speed, etc.). Sponges are frequently found in the river’s falls and especially in the region of Salto Grande dam. In this area, and before the dam was built, the Uruguay River had a remarkable fauna of incrusting and arborescent sponges. The particularities that characterised the aquatic biota have been altered by the construction and operation of Salto Grande, a process in which a considerable number of fish species upstream from the works is affected, probably as a result of a lack of efficiency of the corresponding fish ladder built to avoid or reduce impact on migratory species (Bonetto & Hurtado, 1998).

Other benthonic species, such as molluscs, are abundant as well and with high diversity. There are two or three types of *Biomphalaria* among which *B. Tenagophila* is dangerous due to its capacity for propagation of schistosomiasis (Bonetto & Hurtado, 1998).

The ichthyic fauna of the Uruguay River is dominated by Characiforms and Siluriforms but it lacks diversity if compared with that of the Paraná River, with some 130 species recorded: 40 Characoidei (39%), 50 Siluriforms (41%), 5 Gymnotodei (3,8%) and 15 Perciforms (11,5%). Characiform predators like *Salminus* and *Brycon* are typical of open waters, whereas *Holpias malabaricus* appears in quiet waters. Among Siluriforms, the ones that inhabit the bottoms, such us Loricariidae ("viejas del agua") are important, whereas the species *Luciopimelodus pati, Pimelodus clarias* and *P. albican* predominate among the Pimelodidae. The "armados" (*Pterodoras granulosus* and *Doras* sp.) are frequent and of fishery interest. Among carnivorous species, the genus *Serrasalmus* (piranhas) stands out. The ichthyofauna of tributaries and marshes adjoining the Uruguay River is mainly represented by the species *Partrygon Iaticeps, Astyanax alleni, A. fasciutus, Acestrorhamphus hepsetus, Brycon bahiensis* and *Colossoma macropomum* (Bonetto & Hurtado, 1998).

"Sábalo" (*Prochilodus lineatus*) is the species with the largest biomass in the system and one of the main fishery resources together with bream (*Leporinus obtusidens*), "dorado" (*Salminus maxillosus*), "patí" (*Luciopimedolus pati*), yellow catfish (*Pimelodus maculatus*), "armado" (*Pterodoras granulosus*) and "surubí" (*Pseudoplatystoma coruscans*). These captures are carried out in general by artisan fisheries considered as subsistence (Genta *et al*, 2004).

6.1.1.2. Near-shore marine environment

The La Plata River constitutes the most important feature of the basin as regards this type of environments. The La Plata River is traditionally divided into three sections: an inner zone, that includes the delta and stretches up to a line that links the cities of La Plata in Argentina with Colonia in Uruguay; an intermediate zone, extended up to the line that links Punta Brava in Uruguay with Punta Piedras in Argentina; and an outer zone, extended up to the line that links Punta Rasa in Argentina and Punta del Este in Uruguay. Mainly in the outer zone alternations in salinity characterise this type of estuarine environment (López *et al*, 2003).

The fish fauna in the inner La Plata River is dominated by Cypriniforms –suborders Characoidei and Gymnotoidei– and Siluriforms. A total of 119 species were identified, with the occasional presence of anadromus and catadromus species (Baigún & Sverlij, 2003). Fish in this area and in the intermediate one are exclusively of freshwaters, with great affinity with those of the Paraná River. Among visiting species, both marine and freshwater, the "machete" (*Raphiodon vulpinus*), "porteñito" (*Parapimelodus valenciennesi*), catfish (*Trachycoristes sp*.) and yellow catfish (*Pimelodus clarias maculatus*) are found, among others. Species worth mentioning are the river anchovy (*Lycengraulis olidus*), which crosses the river in its movements between the Middle Paraná and the Buenos Aires Province marine coast, the sea catfish (*Netuma barba*), which migrates between the sea and the Delta, and the striped mullet (*Mugil* sp.), which performs shorter-range migrations.

Silverside appears with two species: *Odontesthes bonariensis* and *O. perugiae*, which move inwards variably, in migrations along the Paraná River. The increase in carps (*Cyprinus carpio*), an exotic species considered a plague, poses a serious threat to the above-mentioned species and to “sábalo” (*Prochilodus lineatus*) (Bonetto & Hurtado, 1998).

Despite the high species richness, only few of them have been exploited by commercial fisheries. Species of economic and sporting value exhibit migratory patterns that include movements among the La Plata, Paraná, Paraguay and Uruguay rivers. Commercial fisheries dominate both the coast and the pelagic areas, whereas subsistence, sport and recreational fisheries concentrate on coastal areas with greater social importance. The development of commercial fisheries comprises the area between Tigre and Ensenada (Buenos Aires Province), using boats with or without engines and gears such as gillnets, hooklines and shore seines. “Sábalo” was the main target species in the past, captures being mostly for industrial use. Other species such as silverside, “dorado”, bream, “patí”, “surubí” and others are harvested only for food purposes. Trend analyses for commercial landings show a decline after 1950, probably due to “sábalo” catch regulations and coastal contamination (Baigún & Sverlij, 2003).

6.1.1.3. Wetlands

- Paraná River Basin

The main wetlands in the Paraná Basin are the Iberá Marshes, the Submeridional Lowlands and the Paraná Delta, all of them in Argentina. The Pantanal, the largest wetland in the entire La Plata Basin, is located in the Paraguay River Basin.

Iberá Marshes: With some 1,200,000 ha, it crosses the Corrientes Province (Argentina) diagonally. The wetland sits on an extensive plain with a very gentle slope and its outlet is located in the Paraná River through the Corrientes River. This set of wetlands –mainly fed by rain– constitutes a complex association of lentic and lotic environments vaguely outlined on extensive interphase surfaces. The most remarkable units are lagoons of diverse surface and shape, connected with each other and with swamps through diversely defined and active channels, to finally resolve through a vaguely defined drainage system into the Corrientes River. The structure and organisation

Figure 6.1. “Embalsados” in Iberá Marshes

Source: http://www.corrientes.gov.ar/Turismo/

of the aquatic vegetation is very complex, where the "embalsados" –which constitute the lagoons' true limit–, stand out. The "embalsados" are substrates or floating soils formed by organic detritus derived from amphibious plants that are retained by the roots (Figure 6.1). In addition to these, inorganic detritus and new plants also join the floating complex. These "embalsados" can sustain plants of considerable size and even form small forests with specimens of 5 to 8 meters in height, usually with one clear predominant species (Bonetto & Hurtado, 1998).

Submeridional Lowlands: It is a vast depression subjected to an annual flood pulse generated by local rains and by contribution from peripheral areas. It has a scarcely defined hydrographic network, made up of shallow lagoons that are frequently linked. There are numerous waterlogged fields in lowlands due to the presence of impermeable soils. The Northern sector is characterised by having freshwater environments that occupy vast stretches of land (gullies and swamps), where there are some autochthonous fluvial systems that do not allow for an efficient evacuation of water surplus due to their morphological conditions. The Southern sector is dominated by salinisation processes that result from high salt levels in surface waters and in the phreatic layer. Its Eastern border is dissected by a system of connected lagoons that drain great part of the water towards the Salado River. The main vegetation units of the Lowlands include palm groves, straw fields, thickets and halophite turfgrasses. The Chaco shrub-like savannah appears in higher environments, whereas the hardwood forest appears in areas with better drainage (Bucher & Chani, 1998).

Paraná River Delta: It forms an elongated area of 320 km in length that spans up to the La Plata River in a front of a little more than 60 km, covering a surface of some 14,000 km^2 (Figure 6.2). In general terms, depressed and easily floodable areas occupy 80% of the surface against 20% of levees or non-floodable areas. Lentic and swampy environments are usually very shallow, irregular and unstable. In some cases, deeper lagoons may develop, although their margins are densely vegetated by rushes, mainly by *Scirpus giganteus* and *Schoenoplectus californicus*, that are sometimes also surrounded by floating vegetation of *Eichhornia spp*. Biotic communities are of a complex and unstable character and quite affected by pollution and eutrophication phenomena. Most of the fish travelling down the deltaic branches seem to be just in transit

Figure 6.2. Satellital image of the Paraná Delta

Source: http://209.15.138.224/argentina_cartes/STS056-102-4.htm among the three big rivers (Paraná, La Plata and Uruguay). Important concentrations of Argentinean silverside (*Odontesthes bonariensis*) are found in the fluvial branches and migrate in autumn-winter down the Lower and Middle Paraná. Silverside is a very important tourist resource in the Paraná Delta and the nearby sector of the La Plata River (Bonetto & Hurtado, 1998).

- Paraguay River Basin

Pantanal: It is the most important plain of South America's humid areas and it is defined as "the world's major continuous floodplain" (Figure 6.3). Its geographic location is of particular significance since it is the connecting link between the Cerrado[27] in the centre of Brazil, Chaco, Bolivia and the Amazonian region towards the north, and it can be associated with the Upper Paraguay Basin. The Pantanal functions as a large reservoir, producing a gap of up to five months between inflows and outflows. The summer regime determines floods between November and March in the north and between May and August in the south, in this case under the regulating influence of the Pantanal (Dias Coelho, 2004).

Figure 6.3. Pantanal

Source: http://www.pantanal-pocone.net/pantanal/de/pocone_pantanal/pantanal/pantanal.htm

The seasonal flooding pulse, together with the extremely flat conditions of the relief, create a high diversity of terrestrial, aquatic and semi aquatic environments. The higher areas, which are never flooded, are forest belts in the shape of ranges or islands that are locally called "cordilheiras" and "capões", respectively. Some areas have a partial influence of flooding and create quite productive environments, such as floodable fields, floodable forests, abandoned meanders and small intermittent lagoons that receive a great amount of dissolved sediments from the floods. The permanently flooded areas like bays, lagoons, meanders, abandoned meanders and connecting channels are found among the main aquatic ecosystems, providing critical environments to the aquatic biota (ANA-GEF-PNUMA-OEA, 2003).

Due to this enormous diversity of environments and landscapes, the Pantanal has a great diversity of plants and animals, fish, aquatic invertebrates and birds. In the case of birds and animals, the Pantanal plain acts as a big "feeder", both for migratory and resident species. The vegetation in the Pantanal is in a good conservation state due to the low human occupation, limited by the periodic flood. Floodable fields and pioneering formations predominate. Also,

[27] The "Cerrado" is an old plant formation basically compounded by grasslands and savannahs. A brief description of the Cerrado is found in item 6.1.2.

aquatic vegetable communities stand out, such as the water hyacinths (aggregations of aquatic plants) that play an important ecological role in the maintenance of water quality and the protection of river margins and other water bodies (ANA-GEF-PNUMA-OEA, 2003).

Other wetlands of relatively lower importance in the Paraguay River Basin are:

Patiño Marsh (Pilcomayo River): It is part of the North-Northeast border of Formosa Province (Argentina) with Paraguay. An area of great importance for the depuration and sedimentation of the Pilcomayo River waters, which are almost completely silted due to an increase in sediments carried by the river (Bucher & Chani, 1998).

Bañado La Estrella (Pilcomayo River): It is an important area for water storage and sediment deposition during river high flow season, with a surface of some 5,000 ha. It is seriously threatened because annual floods do not reach it like they did in the past, which determines the progressive drying out of the wetland and the consequent invasion of woody shrub-like vegetation (Bucher & Chani, 1998).

Blanca Lagoon (Pilcomayo River): It is located near the confluence of the Pilcomayo and Paraguay rivers in Argentina; part of its surface is protected by the Pilcomayo National Park (Argentina). It consists of a large number of slow-flow rivers and streams, humid lowlands, lagoons and permanent freshwater swamps**,** marshes, seasonally flooded lands, palm groves and forests along the Pilcomayo River. It has the characteristic fauna of Chaco's aquatic environments (Bucher & Chani, 1998).

Bañados del Quirquincho: It is located in Salta Province (Argentina). It is of special importance since it is situated in a relatively dry area of western Chaco, with a very diverse and abundant avifauna (Bucher & Chani, 1998).

Bañados del Itiyuro: It is located in Salta Province (Argentina). It was affected by the construction of Itiyuro dam, which was later filled up with sediments and, as a consequence, the marshland became active again (Bucher & Chani, 1998).

Yema Lagoon (Bermejo River): An important area due to its great biodiversity. Multiple development programmes that include diverting waters through a channel from the Bermejo River are being developed there (Bucher & Chani, 1998).

- Uruguay River Basin

Among the outstanding wetlands of the basin, there are those of the Ibicuy River as well as the so called "bañados del río Uruguay" (Uruguay River Marshes) located in the interfluvial plain of the Ibicuy and Cuareim/Quaraí rivers. These areas are characterised by a flat morphology with a gentle rise to the West, towards the Uruguay River, with the occurrence of some low hills and valleys of little depth. Gramineous prairies almost devoid of arboreal formations predominate within this landscape. The gallery forest is frequently found flanking the drainage network, thus forming a narrow strip but densely populated by species of fairly large size, among which *Peltophorum dubium, P. vogelianum, Tabebuia impetiginosa, Luehea divaricata, Eugenia uniflora, Prunus sellowii* and *Lithraea brasiliensis* can be mentioned (Bonetto & Hurtado, 1998).

6.1.1.4. Floodplains and associated habitats

- La Plata River

Sandy beaches predominate in the Uruguayan bank of the river, forming rather big arcs between rocky ends, with sandbanks, littoral strands and dunes, whereas the Argentinean bank forms an extensive low coastal plain with development of swamps, lagoons, big tidal and flood fills and old beach strands. Areas of active dunes and dune ranges with swamps alternate southwards from Punta Rasa (Argentina) (Giordano & Lasta, 2004).

As regards the vegetation associated to these geoforms, saline soils covered with halophyte vegetation are observed on the Uruguayan bank, whereas gramineous plants with some arboreal formations predominate on the Argentinean bank. The Uruguayan bank is dominated by the halophytes *Juncus acutus*, *Spartina montevidensis* and *Salicornia fruticosa* among others, whereas the Argentinean one is populated by various gramineous associations, mainly cattail fields, riparian prairies and esparto fields (Bonetto & Hurtado, 1998).

- Paraná River

In the Argentinean-Paraguayan Upper Paraná, the alluvial plain is of recent formation, made up of associations of permanent and semi-permanent water bodies that are periodically flooded by the river; it comprises brooks and lagoons of elongated or regular shape. The plains are poorly to moderately developed, and in the East-West section, they are subjected to the influence of Yacyretá dam; the plain is very narrow on the Paraguayan bank, whereas on the Argentinean one there are scarce water bodies isolated by levees. In the Argentinean Middle and Lower Paraná, the floodplain expandes again, reaching its greatest development. It starts in the vicinity of the confluence with the Paraguay River and it stretches along the right bank in the Middle Paraná and on the left in the Lower Paraná.

The vegetation covering the floodplains is organised in a series of levels ranging from rooted aquatic plants of shallow waters to more desiccation-tolerant ones, such as *Echinochloa* spp., *Paspalum repens, Ludwigia peploides*, etc, to species more characteristic of rather elevated areas, such as the "paja brava" (*Panicum prionitis*), that practically reach the marginal vegetation (Bonetto & Hurtado, 1998).

The profusion and diversity of the aquatic flora, especially on the banks of the rivers, their tributaries and the lentic environments of the floodplain, enable the development of a characteristic fauna. Worthy of special mention are those that settle on the roots of free floating plants (pleuston), such as *Salvinia* spp., *Pistia stratiotes* and *Eichhornia* spp, which can sustain a very diversified and abundant fauna. In this, molluscs predominate, at least as regards the biomass in the Middle and Lower Paraná (Bonetto & Hurtado, 1998).

The littoral lagoons and lentic environments of the floodplain play a key role in fish breeding. The great migratory fish gathered in favourable places start multiplying during high water, and the eggs, larvae and fry produced enter the lentic environments where they find favourable conditions for their breeding ("nursery areas") (Bonetto & Hurtado, 1998).

A strip of marginal vegetation of diverse importance and complexity develops along the Paraná River and its tributaries. It is composed of the gallery forest and it is closely related to the microclimate generated by the river. At its distal end, there is a penetration of elements coming from the characteristic gallery forest of the Uruguay River that intermingle with those from the Paraná River and even reach a certain length in the La Plata River. The pioneering vegetation settles on sandbanks, giving rise to the "sauzales" (*Salix humboldtiana* forests) and the "timbosales" (*Tessaria integrifolia* forests), whose contribution is seen in the Paraná River from the Paraguay River. Much more significant vegetation develops on the margins due to the size of specimens, levels of organisation and other attributes, which can extend over a considerable lateral area or be reduced to insignificant levels. The marginal vegetation of both Paraná and Uruguay rivers is much degraded and deforestation has taken on alarming characteristics in certain areas (Bonetto & Hurtado, 1998).

- *Paraguay River*

The Paraguay River evolves into meanders, overflowing during the floods phase. Abandoned meanders in the shape of a horseshoe –known as oxbow lakes– stand out along Paraguay River course, forming "mouths" in their marginal levees. The river also has extensive gallery forests on its margins, which harbour a great diversity of fauna and they are thus very important for nesting. It also has big concentrations of diverse fish species (Rocha Acevedo, 2001).

Pilcomayo River: Its plain is the result of the frequent overflows of the river, which deliver high amounts of sediment. The morphogenic activity is very dynamic, which causes the instability of its course and of the entire neighbouring region. This process has increased considerably over the last decades due to the violent process of erosion that takes place in the upper basin as a result of overpasturing and deforestation, with an estimated transport of about 100 hm^3 of sediments per year. This, in turn, has dramatically increased the course silting and the filling of wetlands associated to the river, as is the case of the Patiño Marsh, for example. As regards vegetation, plain forests alternate with carob tree forests, palm groves and very diverse pastureland and turfgrass systems (Bucher & Chani, 1998).

Bermejo River: Its plain is complex, with a chaotic pattern that results from the modelling caused by the lateral movements of the rivers. Relictual riverbeds fed by the overflows of the Bermejo River are just partially active, and even though they are well defined in their runoff section, the courses are frequently interrupted. These interruptions slow down the water's propagation speed considerably, favouring its accumulation in the riverbed and forming first-magnitude natural reservoirs (marshes, etc.). The dominant vegetation includes hardwood "quebrachales" (quebracho forests), the "espartillar" (esparto field) and the *Prosopis* savannah. "Palosantales" (palo santo groves), "algarrobales" (carob tree groves) and halohygromorph environments that include marshes of vinal shrubs, palosantal-cardonal (palo santo-cardon cactus groves), etc., predominate in the Bermejo River (Bucher & Chani, 1998).

- Uruguay River

The riparian and aquatic vegetation is profuse, even though the latter is not permanent in the main riverbed due to the varied changes in the water level, abrupt margins and rocky substrates. Typical species predominates include diverse *Podostemum* in rocky substrates and *Cabomba australis* and *Ceratophyllum demersum* prairies in protected areas. Rushes of

Schoenoplectus californicus that provide the habitat for floating species like *Salvinia* spp., *Azolla caroliniana* and *Ludwigia peploides*" are also commonly found (Bonetto y Hurtado, 1998).

6.1.2. Terrestrial biogeographical units

In the La Plata Basin there are at least four great clearly defined biogeographic units: the Gran Chaco Americano, the Praderas, the Cerrado and the Atlantic Forest (Map 6.1).

Map 6.1. La Plata River Basin. Terrestrial biogeographical units.

The Gran Chaco Americano is a vast region with a clear ecological unit, which has a surface of approximately 1,000,000 km^2 in the centre of South America. Argentina, Bolivia and Paraguay have 95% of Chaco's surface, whereas almost 50% of the total belongs to the former. The region presents a great diversity of environments with extensive plains, sierras, big rivers crossing it, dry and floodable savannahs, swamps, marshes, saltpetre beds, and a great extension and diversity of forests. As a result, there is a high diversity of animal and vegetable species that make up a key area in terms of biodiversity conservation. It has wide thermal ranges, a heterogeneous water potential and, in general, soils with good fertility levels (CIC, 2005).

The Praderas are characterised by fertile soils, lack of trees and a rather flat topography. They are found among the ecosystems with the greatest percentage of modified territory and with a growing pressure of farming crops for export, as is the case of the Uruguayan Savannah and the Argentinean Pampas. The ecoregion comprises the south of the Brazilian State of Río Grande do Sul, the entire Uruguayan territory and east central Argentina, between the provinces of Buenos Aires, Córdoba and Corrientes (CIC, 2005).

The *Pampa* is a plain with no trees of natural growth. It has around 600,000 km^2 and presents a continuous and permanent coverage of grasses that hide the ground. Due to its homogeneity, enormous extension and suitability, it is one of the world's largest prairies. Northwards, the landscape changes with the presence of scattered trees as it approaches the border of Chaco. Towards the West, the prairies meet one of the raised borders of the basin, the *Sierras Pampeanas* (Pampeanas Hills). Towards the West and South, there is a steppe that continues the flat relief but shows the progressive lack of water. On the other hand, the *Uruguayan Savannah* comprises a vast region as well, devoted to agriculture. In Uruguay, the most fertile soils are located in the basin and mainly devoted to agriculture (CIC, 2005).

The Cerrado domain occupies an extensive area of Brazil with its centre in the *Planalto Central* (Central Plateau) region, reaching Paraná State towards the South. Forty five percent of the area has been turned into cultivated pastures and tillage lands. The cerrado biome predominates in it, which is specifically terrestrial, of a great dimension, with more pronounced ecological characteristics, in spite of which, there is not a single physiognomy throughout the entire cerrado domain. On the contrary, it presents both very open rural forms, such as the cerrado open fields, to relatively dense forest forms, such as the Atlantic-type gallery forests along the humid valleys of the rivers, including a series of intermediate forms, sometimes as islands or spots (caatingas) (CIC, 2005).

The Atlantic Forest originally extended throughout the entire Brazilian littoral, entering the continent and advancing towards Argentina and Paraguay. It is a single ecosystem present in the three countries, of which only about 10% of its original surface remains nowadays. It consists of various woody formations that include, among others, three types of forest formations as well as mangrove swamps and shoals. It is characterised by a set of forest ecosystems and quite differentiated arboreal compositions, following the climate characteristics of the vast region where it occurs, whose common element is the presence of humid winds coming from the ocean. The Atlantic Forest encloses a great richness of genetic and landscape heritage, which places it among the world's five main hotspots, with different conservation levels in the three countries sharing it (CIC, 2005).

6.2. Programmes and strategies

6.2.1. Protection of ecosystems

As regards the protection of ecosystems in the basin, a summary of the main pressures detected in the three major sub-basins (Paraná, Uruguay, La Plata) is firstly presented. The legislation and decision-making aspects related to water sources protection, ecological potential, species protection and habitat restoration programmes are presented according to the information existing in the riparian countries.

6.2.1.1. Pressures induced by human activities on freshwater ecosystems

- <u>Paraná River Basin</u>

The human pressures detected are: oil and mining activities, agriculture, energy production, transport infrastructure, alteration of courses, advance of the agricultural and livestock frontier, urban expansion, pollution, construction of dams, habitat fragmentation, overexploitation of resources, tourism/recreation, destruction of the basin's vegetation and overpopulation (Bonetto & Hurtado, 1998).

- <u>Uruguay River Basin</u>

The human activities that exert pressure on water resources are: oil and mining activities, agriculture, energy production, transport infrastructure, alteration of courses, advance of the agricultural and livestock frontier, urban expansion, pollution, construction of dams, habitat fragmentation, overexploitation of resources and destruction of the basin's vegetation (Bonetto & Hurtado, 1998).

On the other hand, the negative impact of the Salto Grande dam is unknown, except urban floods and relocation problems, as well as the generalised opinion of a highly detrimental influence on the ichthyofauna –due to the poor efficiency of the fish ladder system, among other factors– and the severe decrease in the benthonic community, especially in its characteristic poriferan fauna (Bonetto & Hurtado, 1998).

- <u>La Plata River</u>

The human activities that exert pressure on water resources are: harbour activities and industrial activities (including loading and unloading of oil-based products), agriculture, energy production, transport infrastructure, advance of the agricultural and livestock frontier, urban expansion, pollution, habitat fragmentation, overexploitation of resources, tourism/recreation, destruction of the basin's vegetation and overpopulation (Bonetto & Hurtado, 1998).

The increase of carps (*Cyprinus carpio*) –exotic species considered a plague– in population density and territorial expansion, poses a serious threat to silverside (*Odontesthes bonariensis*) and "sábalo" (*P. lineatus*) as well as to other species. Worthy to be mentioned are the Asian invasive molluscs (*Corbicula fluminea*, *C. largillerti* and *Limnoperna fortunei*) due to the serious risk of pipe obstruction they pose, mainly as a result of their quick propagation and high population density, in which the latter species, of recent entrance into these waters, stands out (Canevari *et al.*, 2001).

Worthy to be mentioned as well are important pollution phenomena and water eutrophication that cause high fish mortality, especially of “sábalo” due to anoxia phenomena (Canevari *et al.*, 2001).

Table 6.1 shows a classification of the identified threats and impacts on significant wetlands and water bodies according its severity (high, medium or low threat). The table also includes an evaluation of the importance of these areas, considering their biological value and their ecological benefits.

Table 6.1. La Plata River Basin. Biological value, benefits, impacts and threats in significant water bodies and wetlands

Significant wetlands and water bodies	Biological value	Benefits	Impacts and threats
Iberá System	H	M	H
Uruguay River	M	H	M
Paraná River	H	H	H
Paraguay River	H	H	H
Iguazú River and its waterfalls	H	H	H
Delta Paranaense	M	H	H
La Plata River	M	H	H

H: high M: medium Source: Adapted from Bonetto & Hurtado, 1998

6.2.1.2. Protection of water sources and quality

In general, protection of water sources and control of their quality in terms of sustenance of the biota are regulated in all the countries through programmes and projects implemented by environmental agencies and/or those responsible for water resources.

In the case of Argentina, the *Dirección Nacional de Conservación y Protección de los Recursos Hídricos* (National Directorate of Water Resources Conservation and Protection) under the *Subsecretaría de Recursos Hídricos de la Nación*, SSRH (National Undersecretariat of Water Resources) is in charge of preparing studies and diagnoses of water resources conservation and protection status for the different river basins and establishing the guiding environment water quality levels as referential criteria to define its suitability in terms of the uses assigned to it. These objectives are fulfilled through the implementation of the Water Quality Programme, which in 1998 gave start to the elaboration of the Guiding Water Quality Levels, an activity performed on a permanent basis. The guiding levels set referential quality guidelines for safeguarding the biotic components involved in the following goals associated to environment water: a) source of water supply for human consumption; b) protection of aquatic biota; c) crop irrigation; d) beverages for species destined to animal production; and e) human recreation (SSRH, 2004). The parameters set in the guiding levels have been submitted for consideration of the *Secretaría de Ambiente y Desarrollo Sustentable*, SAyDS (Secretariat of Environment and Sustainable Development), which is the national environmental authority and exercises its police power in connection with industrial water pollution for Buenos Aires Metropolitan Area.

In Bolivia, the *Ministerio de Desarrollo Sostenible y Planificación*, MDSP (Ministry of Sustainable Development and Planning), with its *Viceministerio de Recursos Naturales y Medio Ambiente* (Viceministry of Natural Resources and Environment), is the environmental authority that applies and exercises surveillance of water quality according to what the Regulation in Connection with Water Pollution establishes. This Regulation was enforced in 1995 (Supreme Decree 24,176) and it rules the General Environmental Law 1,333/92. Its section 4 classifies water bodies according to the suitability of their uses, establishing the limiting values of the polluting load allowed for the use of water for the protection of hydrobiological resources (Congreso Nacional de la República de Bolivia, 1992). The departmental prefectures share surveillance for the observance of these aspects together with the Ministry. Once the environmental authority fixes the type of water according to the typology set by the Regulation, the specification must be kept for a period of 5 years.

In Brazil, the National Water Resources Policy Act 9,433/97, known as the “Waters Act” defined five essential instruments for the proper management of water resources, among which the classification of water bodies according to the predominant water uses is found. This is fundamental to establish a system to monitor spring water quality levels. Besides, it is an instrument that allows linking the qualitative and quantitative aspects in the management of water quality. In other words, it strengthens the relationship between water resources management and environmental management, because its execution is based on the National Environmental Policy through Resolution 20/1986 of the *Conselho Nacional do Meio Ambiente*, CONAMA (National Environmental Council) (Praciano Minervino, 2002). According to this rule of CONAMA, tolerance levels for diverse polluting elements in the water are set in order to preserve the natural balance of aquatic communities (Special Type) or the protection of said communities (Types 1 and 2) (CONAMA, 1986 b). The *Secretaria de Recursos Hídricos*, SRH (Secretariat of Water Resources) of the *Ministerio do Meio Ambiente*, MMA (Ministry of Environment) proposes to set forth the national policy and it supports and monitors its implementation, whereas the *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*, IBAMA (Brazilian Institute of Environment and Natural Renewable Resources) is the one that controls, supervises and monitors water environmental quality within the federal domain.

In Paraguay, the *Secretaría del Ambiente*, SEAM (Secretariat of Environment) is the national environmental authority that is entitled, among other things, to propose environmental levels and standards, carry out the technical standardisation and exercise environmental control and monitoring (Secretaría del Ambiente de la República del Paraguay, 2004). Within this framework, the Secretariat passed Resolution 222/02 that establishes the Water Quality Pattern enforced in the national territory. The Resolution classifies waters into four types according to their quality, types 1 and 2 corresponding to protection of aquatic communities and species breeding for human feeding. It also establishes the maximum tolerable values of polluting substances for each class (Secretaría del Ambiente de la República del Paraguay, 2002). The *Dirección General de Protección y Conservación de los Recursos Hídricos*, DGPyCRH (General Directorate of Water Resources Protection and Conservation), an agency with the rank of State Undersecretariat within the SEAM, is the maximum authority of the water sector and it is in charge of coordinating and assessing water resources maintenance and conservation policies and looking after the different uses, among other functions (Gamarra Lovera, 2002).

In Uruguay, the functions related to water quality control are in charge of the *Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente*, MVOTMA (Ministry of Housing, Territorial Planning and Environment), through the *Dirección Nacional de Medio Ambiente*, DINAMA (National Directorate of Environment). The DINAMA draws up, implements and supervises plans to assess and measure water resources quality level and plans to control the activities that have an effect on resources quality. As regards the legislation regulating water quality, the Water Code contains rules referring to water quality and it entitles the environmental authority to pass provisions and apply measures that prevent the resource degradation. The Environmental Pollution Prevention Regulation of 1979 (Decree 253/79 and amendments) establishes the classification of water bodies and pollution parameter limits (von Cappeln, 2002).

As regards the management of shared resources, the cases of the Uruguay and the La Plata rivers stand out, both shared by Argentina and Uruguay. The *Comisión Administradora del Río Uruguay*, CARU (Administrative Commission for the Uruguay River) is empowered to prepare and pass a series of rules intended to manage the river. Within this framework, the governments of the two countries passed the *Digesto de Usos del río Uruguay* (Digest on the Uses of the Uruguay River), which is a body of rules on different issues (CARU, 1994). In Topic 3 of the Digest, specific rules for pollution have been established, setting water quality standards for the river according to the uses that are to be protected. Use 4 (waters for aquatic life conservation and development) is the one defined as Basic and its standards must be complied within the entire river. The standards adopted by CARU are highly strict compared with other international rules, most especially in the parameters related to heavy metals and plaguicides. Besides, CARU carries out plans and projects specifically related to water quality, such as the *Plan de Protección Ambiental del Río Uruguay* (Uruguay River Environmental Protection Plan) and the *Programa de Calidad de Aguas y Control de la Contaminación del Río Uruguay*, PROCON (Uruguay River Water Quality and Pollution Control Programme), which includes an intensive water monitoring and a coast sampling programme (CARU, 2005).

In the case of the La Plata River, the *Proyecto Protección Ambiental del Río de la Plata y su Frente Maritimo: Prevención y Control de la Contaminación y Restauración de Habitats*, FREPLATA (Project on Environmental Protection of the La Plata River and its Maritime Front: Pollution Prevention and Control and Habitat Restoration) is a joint Argentinean-Uruguayan initiative, financed by GEF and coordinated by the *Comisión Administradora del Río de la Plata*, CARP (Administrative Commission for the La Plata River) and the *Comisión Técnica Mixta del Frente Marítimo*, CTMFM (Joint Technical Committee for the Maritime Front). Its objective is to prevent and mitigate the degradation of the transboundary resources of the La Plata River and its Maritime Front and contribute to its sustainable use by the inhabitants of both riparian countries. To do so, a transboundary diagnostic analysis has been made and actions have been designed to integrate a Strategic Action Programme to be implemented by both riparian countries (CARP-CTMFM, 1998). According to a report of FREPLATA, in Uruguay the policy and legislation concerning water utilisation and control appear to be much more centralised, but in neither country are they effective to prevent the huge pollution of the La Plata River caused by populated coastal centres. Both countries have provisions relating to the dumping of hazardous substances with industrial permit, etc., but the legislations prove to be insufficient when it comes to water quality control and its periodic classification, and with respect to the problem of final waste disposal (Zeballos de Cisto *et al.*, 1998).

6.2.1.3. Application of Environmental Impact Assessment

The five riparian countries have established environmental impact assessment mechanisms in general, which also apply to the utilisation of water resources. The enforcement authority, in all cases, belongs to the environmental agencies. Table 6.2 summarises the information on these aspects.

Table 6.2. La Plata River Basin. Main Environmental Impact Assessment laws by country

Countries	Legislation	Institution	Observations
Argentina	Law 23,879/90 and amendments	SAyDS	Concerning hydraulic works with hydroelectric development.
Bolivia	Law 13,33/92	MDSP	The Ministry passes, rejects and supervises the EIA, together with the sectorial ministries and departmental Environmental Secretariats.
Brazil	Law 6,938/81 and Resolution CONAMA 1/86 and 237/97	IBAMA	The environmental assessment is carried out by environmental agencies at a state level.
Paraguay	Law 294/93	SEAM	The Law specifically refers to any work that might alter the hydrological regime.
Uruguay	Law 16,466/94	DINAMA	

Source. Tarak *et al.*, 1997

With specific reference to the protection of waters and their ecosystems, Argentina has national rules to prevent the possible environmental impact that the introduction into the country of species for productive purposes (aquaculture) might have on natural ecosystems. In this sense, Resolution 987/97 of the *Secretaría de Agricultura, Ganadería, Pesca y Alimentos,* SAGPyA (Secretariat of Agriculture, Livestock, Fishing and Food), establishes the rules that regulate the production of live aquatic organisms in the Argentinean territory. It also determines the introduction ways and the steps to be followed to that end. The rule establishes the prohibition on the transport and sale of exotic species within the territory, without authorisation from the competent authority, with prior analysis of the risk of disseminating no desirable species. The resolution particularly regulates the handling of both individuals as well as derivates of Cyprinids (carps) and Salmonids (trouts and salmons) and it establishes the prohibition on the introduction of a list of crustacean and freshwater fish species (Mugetti, 2004).

In the case of Bolivia, the Wildlife, National Parks, Hunting and Fishing Act establishes the express prohibition on the introduction and spread of new fish species and other aquatic animals without previous authorisation from the enforcement authority, in this case the *Centro de Desarrollo Forestal* (Forest Development Centre). It also prohibits the spread of species foreign to the different water bodies without express authorisation, as a means of protecting the biodiversity of each one of them. (Congreso Nacional de la República de Bolivia, 1975).

In Brazil, Law 6,938 considers that every work (be it construction, installation, enlargement or operation) that might be considered as having an impact on environmental resources depends on the granting of an environmental permit by the state environmental authority. Likewise, CONAMA resolutions establish the general guidelines for the use and implementation of the impact assessment for hydraulic works of water resources exploitation, sanitation and irrigation, opening of channels for navigation and irrigation, straightening of watercourses, diversion between basins and dams, among others (CONAMA, 1986 a), and they define the concepts of license and regional environmental impact studies (CONAMA, 1997).

On the other hand, the Environmental Crimes Act 9,605/98 punishes environmental pollution that causes animal mortality or flora destruction, as a result of, among other causes, solid, liquid or gas waste disposal outside current regulations (Praciano Minervino, 2002). Killing, chasing and hunting wild fauna, whether native or in migratory route, without the respective permit, are also considered environmental crimes. Selling, exhibiting, purchasing, keeping, using and transporting wild fauna's eggs, larvae or species from unauthorised breeding facilities or without due permit from a competent authority are also punished. As regards aquatic fauna, the law punishes fishing during closed seasons or in places prohibited by the competent authority, referring to fishing as any activity intended to remove, extract, collect or capture fish, crustacean, mollusc and aquatic plant specimens susceptible or not to economic utilisation (Presidência da República do Brasil, 1998).

In Paraguay, the Fishing Act 799/95 establishes the binding force to perform an environmental impact assessment study in the event of the construction of any work that could alter the hydrological and hydrobiological regime of rivers. These works will need to have appropriate measures to preserve fish habitat and migratory movements. The introduction of exotic species, on the other hand, will have to be carried out with the permission of the competent enforcement authority. Finally, the law foresees sanctions for different infringements within the fishing activity, such as carrying out the activity without the corresponding license; the capture, transport and trade during closed season, in reservation areas or without the statutory weight; carrying out these activities through unauthorised methods that could endanger human life and the existence of resources; and the introduction of live specimens into the country without the corresponding authorisation (Cámara de Senadores del Paraguay, 1995).

In Uruguay, the *División Evaluación de Impacto Ambiental*, DEIA (Environmental Impact Assessment Division) implements, within the structure of the DINAMA, the Environmental Assessment Act and its corresponding Regulations. As a result, the new undertakings whose implementation, according to the above-mentioned Regulations, is required to have the Previous Environmental Authorisation, present the Project Communication as a first step. As regards live aquatic resources, the regulation concerning extraction and introduction is encompassed in Law 18,838 of Ocean's Riches[28]. Such Law foresees the rational exploitation of live aquatic resources so as to obtain a constant optimum yield. It also prohibits the dumping of substances that are harmful for water use or destroy the flora and fauna (especially hydrocarbons, industrial and reactive waste), determining as well the prevention

[28] Besides the Uruguayan maritime sector, the law also comprises the common fishing area that Uruguay shares with Argentina in the La Plata River.

measures intended to prevent pollution. Finally, the Law prohibits the export of live species or the import of exotic species, whatever their evolution stage is, or else the introduction of species into inside waters without the corresponding authorisation (Poder Legislativo de la República Oriental del Uruguay, 1969).

6.2.1.4. Species protection plan

Aquatic biodiversity protection is encompassed in the legislation of the riparian countries, most especially as regards the extraction of certain species of high economic value. In all cases, the control of these activities is in charge of environmental agencies.

In the case of Argentina, aquatic biodiversity conservation mechanisms are implemented through different rules, interjurisdictional agreements and the adherence to international conventions. Depending on each case, these mechanisms generate actions on aquatic ecosystems, the extraction of resources or the production and management of certain species (Mugetti, 2004). The *Grupo de Trabajo de Recursos Acuáticos*, GTRA (Aquatic Resources Working Group) that operates in the SAyDS is in charge of proposing projects and programmes intended to the research, conservation and sustainable use of wetlands, aquatic biodiversity and marine, fluvial and lacustrine fishing, with the technical assistance of scientific and academic institutions as well as the agreement and participation of the competent national, provincial and municipal authorities and institutions. Besides, it proposes actions for the sustainable management of fisheries and the conservation of aquatic biodiversity with the competent jurisdictional, national and provincial areas (GTRA, 2004).

In Bolivia, Law 12,301 of Wildlife, National Parks, Hunting and Fishing sets forth the rules for the conservation, use, transport and trade of fishery resources, whereas the *Centro de Desarrollo Forestal* (Centre of Forest Development) of the MDSP is in charge of legislating, regulating and auditing said activities. The Law establishes that each water body receiving fishery resources will have specific regulations, in which species, exploitation volumes, capture methods, closed and fishing seasons and other inherent aspects will be encompassed. It also includes forecasts concerning the resource conservation, the use of water for other purposes (water intakes, canalisations, sinks of all waste types) and the protection of the basins, establishing specific measures on the felling of forests (Congreso Nacional de la República de Bolivia, 1975).

In Brazil, aquatic species conservation and management is in the charge of IBAMA, through two specific divisions: the *Centro de Pesquisa e Gestão de Recursos Pesqueiros Continentais* (Continental Fishery Resources Research and Management Centre) and the *Programa Nacional de Desenvolvimento da Pesca Amadora*, PNDPA (National Amateur Fishing Development Programme). The former has the mission of contributing to the sustainable use of continental fishery resources through the generation and dissemination of scientific, technological and environmental knowledge and of implementing national environmental policies. The latter, on the other hand, seeks to turn the fishing activity into a tool of economic and social development and environmental conservation; it is in charge of issuing fishing permits and determining closed seasons, with the agreement of state governments (IBAMA, 2005).

The DGPyCRH of the SEAM is in charge of developing and fostering plans, programmes and projects related to ichthyofauna research in Paraguay. It also promotes programmes and projects that aim at the sustainable use of ichthyic and aquaculture resources, in agreement with the regional economic development, especially in the most unfavoured areas of the country. Fishery Law 799/95 regulates fishing and related activities in rivers, streams and lagoons under public or private domain. The SEAM is the Law enforcement authority and determines the species, sizes, fishing times and places, closed seasons and fish catch volume, verifying strict compliance. It also establishes mechanisms for the protection of vital ecosystems for fish, such as spawning places. As regards species introduction, the law specifies that it will only be possible by means of a permit issued by the enforcement authority (Presidencia de la República del Paraguay, 1995).

In Uruguay, the fishery-related policy is under the responsibility and competence of the *Dirección Nacional de Recursos Acuáticos*, DINARA (National Directorate of Aquatic Resources), which acts particularly in the Common Argentinean-Uruguayan Fishing Area of the La Plata River. The DINARA is also in charge of promoting and regulating aquaculture, passing rules and establishing the activity parameters, according to what Law 14,484 of 1975 establishes. The DINARA has its Fishery Research and Aquaculture Centre on the banks of Salto Grande reservoir; in this centre, activities connected with research, experiment, seed production and technology transfer are carried out (DINARA, 2004).

As regard shared basins and water resources, the Republic of Paraguay and the Republic of Argentina subscribed an agreement in 1971 for the bordering rivers and created the *Comisión Mixta Argentino-Paraguaya del Río Paraná*, COMIP (Argentinean-Paraguayan Joint Commission of the Paraná River), with the aim of studying and assessing the resource development possibilities (including ichthyic resources) of the Paraná River in the bordering section between the two countries. COMIP has worked to establish a set of rules that allows for a common regime on four important aspects for the ichthyic resources conservation: closed periods, minimum size of caught fish, allowed fishing arts and areas kept as a resource reservation. Within the framework of the successive counterpart meetings, the Unified Fishing Regulations have been endorsed and the closed seasons have been established. Likewise, different documents were produced, which gave birth to the *Proyecto Regional de Evaluación de Pesquerías en las Cuencas de los Ríos Paraná y Paraguay* (Regional Project for Fisheries Assessment in the Paraná-Paraguay River Basins). The COMIP has also worked to foster measures to prevent predatory fishing in the Yacyretá dam area. As a result, an agreement to establish the fishing closed season in the spillways area up to 3 kilometres upstream and downstream from the mentioned dam was signed (Mugetti, 2004).

In the Uruguay River, CARU has responsibility for the conservation, use and exploitation of aquatic resources and it will have to regulate fishing activities carried out in the river. On the other hand, the agency is empowered to agree upon maximum catch volumes, when required by the intensity of the activity. In this regard, CARU imposed fishing closed season in 1998 and 2000 (CARU, 2000 b). CARU also carries out research activities intended to the responsible conservation and use of the resources; thus, the monitoring of the ichthyofauna in Salto Grande reservoir and the monitoring of eggs and larvae in the lower Uruguay River were under way at the beginning of 2000s (CARU, 2000 b). Finally, fishery resources are one of the strategic areas encompassed in the Uruguay River Environmental Protection Plan.

- Habitat reserves

There are different categories of protected areas whose objective is keeping significant portions, both in terms of the resource preservation as a food source for ecosystems as well as the biota. These areas are included in the protected areas systems under the environmental institutions of the five countries. The areas categorised by some current international conventions are included in such systems, among which the Ramsar Convention stands out due to the importance it has for the conservation of aquatic and wetlands ecosystems.

The five countries have signed the Ramsar Convention on Wetlands. The first of them was Uruguay, where the Convention came into force in September 1984. In the rest of the countries the Convention came into force in 1990 (Bolivia), 1992 (Argentina), 1993 (Brazil) and 1995 (Paraguay). There are 15 Ramsar sites in the basin covering an area of 5,474,308 ha (Ramsar, 2004). The distribution by country is shown in Table 6.3 and more details about the sites are included in Annex II.

Table 6.3. La Plata River Basin. Number and surface of Ramsar sites by country

Country	Ramsar Sites (number)	Area
Argentina	5	1,323,550
Bolivia	2	3,195,388
Brazil	2	169,400
Paraguay	6	785,970
Total	15	5,474,308

Note: Uruguay has no Ramsar sites in the La Plata Basin
Source: Ramsar, 2004.

6.2.1.5. Restoration of degraded ecosystems

At international level, the *Integrated Watershed Management Practices for the Pantanal and Upper Paraguay River Basin Project* also known as the *GEF Pantanal/Upper Paraguay Project*, is being developed with resources from GEF (Global Environment Facility), with the participation of the *Agência Nacional de Águas,* ANA (National Water Agency), UNEP (United Nations Environment Programme), OAS (Organization of American States), Mato Grosso and Mato Grosso do Sul states, as well as several other organisations. Its objective is to promote sustainable development at the Upper Paraguay Basin, which includes all the Pantanal, supporting priorities identified in the Upper Paraguay Basin Conservation Plan (PCBAP), and promoting a Strategic Action Programme (SAP), that will contemplate the main investments within the basin (ANA-GEF-UNEP-OAS, 2005).

In this context, the GEF Pantanal/Upper Paraguay project seeks to achieve important goals related to improvement in environmental processes, restoration of the main ecological systems and protection of the flora and fauna present in the Pantanal, especially of endemic species. All of this is linked to the strengthening of basin institutions, the creation of an organisational capacity and the integration of environmental matters in sustainable economic development. In the assessment of the fundamental causes of basin degradation, this Project combines activities that complement other actions of the Brazilian government in the basin, financed both by national and state sources as well as international loans (ANA-GEF-UNEP-OAS, 2005).

The project has six components: 1) water quality, 2) Pantanal conservation, 3) soil degradation, 4) concerned people involvement and sustainable development, 5) organisational structure development and 6) integrated management programme implementation. In the second one (Pantanal conservation), inter-related themes that refer specifically to the protection and conservation of fauna and flora are dealt with. Among them, there is the creation of Conservation Units in the Pantanal, as a way of preserving the natural habitats in this region, as recommended by the PCBAP (ANA-GEF-UNEP-OAS, 2005).

At a national level, the case of Bolivia can be mentioned, where Law 12,301/75 of Wildlife, National Parks, Hunting and Fishing empowers the *Centro de Desarrollo Forestal* (Centre of Forest Development) of the MDSP to adopt the necessary measures to preserve or restore the habitat of wild animals (soils, flora and waters) that require organisation and management plans and to pass relevant resolutions to prevent pollution of any kind, and at the same time it will put into practice actions required for the sanitation of those affected environments (Congreso Nacional de la República de Bolivia, 1975).

6.3. Policy guidelines for governance

6.3.1. Land use and ecological policies

In Argentina, the SAyDS is the national environmental authority and it has responsibility for environmental preservation and protection, the implementation of sustainable development and the rational use and conservation of renewable and non-renewable natural resources, with the objective of reaching a healthy and balanced environment, suitable for human development, according to the provisions of the National Constitution. The SAyDS has expert knowledge in the proposal and elaboration of regulations concerning environmental resources quality, natural resources conservation and utilisation, sustainable development, environmental territorial planning and environmental quality. It is in charge of the environmental territorial planning as well as the planning of the different aspects of the national environmental management and its impact on the quality of life (SAyDS, 2003).

On the other hand, the MINPLAN is in charge of defining and implementing the *Política de Estado de Desarrollo Territorial de la Argentina,* PNDT (National Policy of Territorial Development of Argentina) in the mid and long term, designed to the national territorial planning. The PNDT has the general objective of directing actions with spatial impact towards a balanced, integrated, sustainable and socially fair growth of the Argentinean territory and building more adequate intervention mechanisms to take advantage of development opportunities. The Policy seeks to overcome the sectorial visions of Argentina and build a more systematic and global intervention method, capable of using the development opportunities within the new national and international context. In this framework, the territorial model "Argentina 2016" was set forth, which is intended to achieve a balanced, integrated, sustainable and socially fair country, where the population –both in an individual way and as a group– reaches economic progress and environmental sustainability, promoting a participatory management of the territory (Ministerio de Planificación Federal, Infraestructura y Servicios de la Nación Argentina, 2004).

In Bolivia, regulatory instruments for land use and territory occupation have been developed so as to improve the administrative process that allows defining or cleaning up the political-administrative units. The first law that makes explicit reference to Territorial Planning as an environmental planning instrument is the Environmental Act. After its approval, the Territorial Planning is institutionalised, creating a Undersecretariat within the MDSP. Despite the so many law projects, there is no Territorial Planning Act yet. The municipalities and departmental governments have not adopted at full length the advances in planning either (Blanes, 2003).

There are regulatory technical instruments that seek to optimise land development and guarantee the sustainability of ecosystems and water resources in Bolivia. They consist in land use categorisations based on the existing soils and ecological systems capacity. The legal instrument supporting these plans is Law 1,700, which establishes the zoning category (Crespo Milliet, 2004). Some land use categories that stress water resources protection, such as the categories "Protection lands with limited use" and "Protected Areas", are recognised in general in the agro-ecological zonings, which are the bases for Land Use Plans (Van Damme, 2002).

In Brazil, the federal Constitution establishes the principle of territorial ordering and planning as a tool for environmental policy in its sections 182 and 183. Firstly, competition in connection with zoning corresponds to each municipality. At a national level, the Environmental Policy Law 6,938 takes into account the general ecosystems conservation guidelines as an environmental planning instrument (Tarak *et al*, 1997).

In Paraguay, the *Dirección de Desarrollo Territorial e Integración Regional* (Directorate for Territorial Development and Regional Integration) is in charge of promoting actions at territorial level and participating in regional projects, such as the Paraguay-Paraná Waterway. As regards territorial planning, the country's actions are directed towards developing the rural area, given the special importance of agriculture in the economy. In this sense, it is established that only those lands declared to be suitable (based on prior study) with respect to settlement planning in terms of sustainable use of natural resources will be authorised for agricultural and livestock use (Tarak *et al*, 1997).

In Uruguay, the MVOTMA, through the *Dirección Nacional de Ordenamiento Territorial,* DINOT (National Directorate for Territorial Planning) incorporates the territorial perspective to the set of sectorial interventions of the state at a national and municipal level, supporting the local development of capacities for the proper management of the territory. On the other hand, DINAMA, under MVOTMA itself, seeks to establish an Integrated Environmental Management System centred on prevention and continuous improvement policies.

In 2001, the DINOT started subscribing strategic territorial planning contracts with Departmental Governments, in a policy to support the identification and implementation of key measures for the transformation of territories in general and urban areas in particular. Through this process, the DINOT promoted the elaboration of guiding plans of cities and their immediate surroundings. The strategic plans of the main micro-regions can be quoted as examples: Durazno, Florida, Minas, Paso de los Toros, Centenario, Rincón del Bonete, San Gregorio de Polanco, Trinidad, as well as the guiding plans of Trinidad and Florida (DINOT, 2004).

Challenge: water and human settlements

Overview: Urban areas have increasingly become the focus of human settlements and economic activities, and they present distinctive challenges to water managers.

7. Water and human settlements in the La Plata Basin

7.1. Definition of urban and rural settlements

The five countries have different criteria to define urban and rural settlements and its population. Generally to define a settlement (either urban or rural) the physical criterion predominates, which means the special concentration of certain artificial elements (buildings, streets) easily identified in aerial photographs or updated topographic charts.

The *Instituto Nacional de Estadística y Censos*, INDEC (National Institute for Statistics and Census) from Argentina adopts this criterion to define a *settlement* which is considered a special concentration of buildings connected by streets. Apart from the streets, only minor building discontinuations are accepted (wrapping interstitial lands without edification, narrow water streams, green spaces, etc). This area might be limited by an encirclement starting from a zone recognised as the centre of a settlement; the encirclement reaches any direction where building continuity is interrupted by a long stretch, that is, the open country (INDEC, 2001). On the other hand, local population defines the characteristic of urban or rural. The INDEC defines as *urban population* those settlements with more than 2,000 inhabitants, while rural settlements have fewer inhabitants. When the population of a rural settlement is lower than 500 inhabitants, it is considered “scattered rural population” (INDEC, 2001).

In Bolivia, the *Instituto Nacional de Estadística,* INE (National Institute for Statistics) defines urban population as that of settlements of more than 2,000 inhabitants –according to 1992 census– (INE, 2001).

The *Instituto Brasileiro de Geografia e Estatistica*, IBGE (Brazilian Institute of Geography and Statistics) considers as *urban area* the internal part of the urban perimeter of a city or village, defined by a municipal law. This definition follows the physical criterion, because an urban area is characterised by constructions linked between streets and human occupation. In those cities which do not have legislation on this matter the urban perimeter should be established to collect census data and its limits should be approved by the local municipalities. The *rural area* is the external zone of the urban perimeter (IBGE, 2003 a), although some rural settlements are accepted in the case of permanent groups of people in adjacent buildings (IBGE, 2003 a). On the other hand, the *urban population* is the one living in cities, villages and isolated urban settlements as established by the respective municipalities. The *rural population* is the one living outside the urban area limits, including rural settlements (small towns and others).

In Paraguay (2001 Census) the *urban area* are all official district heads of the country, defined according administrative laws. District heads have blocks, without considering any other special characteristic. The *rural settlement* is the territory located outside the official districts of the Republic (DGEEC, personal communication).

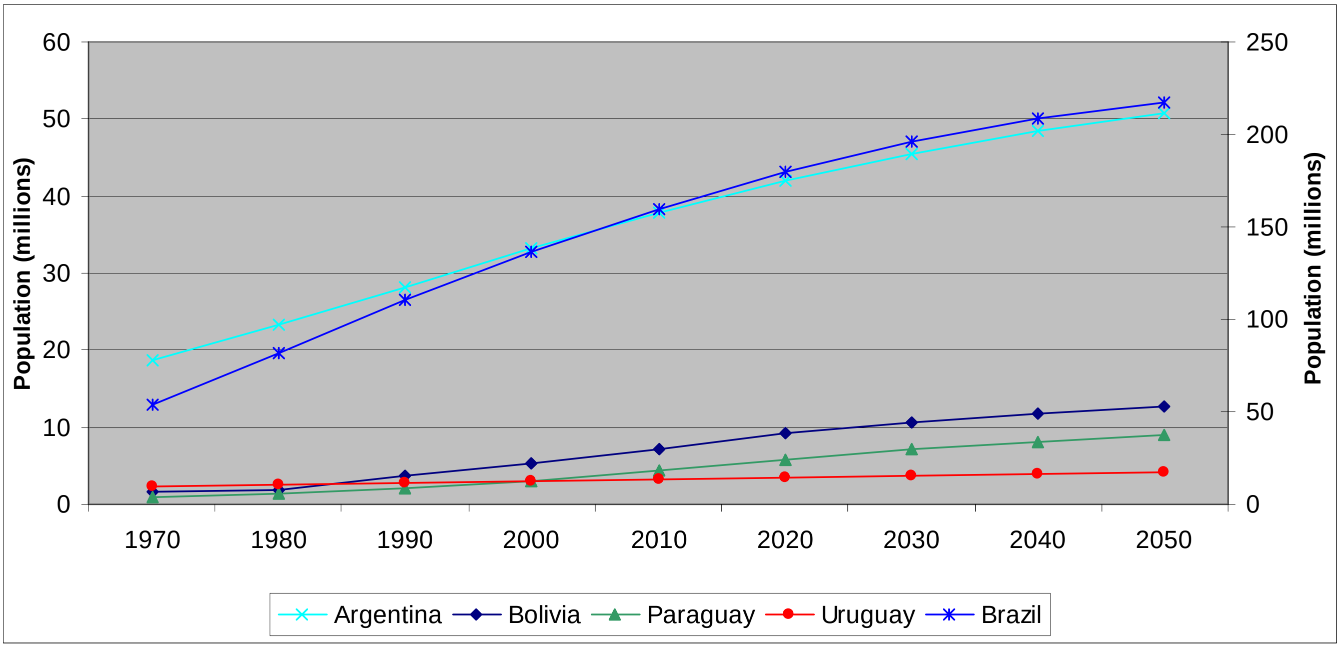
In Uruguay, the definition of *urban population* is based in practical and operative criteria and partially in the dispositions of the settlement Law and further modifications. The *rural population* is defined by exclusion, which means that any population not defined as urban is therefore rural.

7.2. Urban and rural population in the La Plata Basin

Since there are no disaggregated projections of urban and rural populations by departments in Argentina and provinces in Bolivia, the methodology described in Annex I could not be applied. Therefore, it was considered the information published by the *Centro Latinoamericano y Caribeño de Demografía*, CELADE (Latin-American and Caribbean Demographic Centre[29]) depending on the *Comisión Económica para América Latina y el Caribe*, CEPAL (Economic Commission for Latin America and the Caribbean, ECLAC), which studies the variations in urban and rural population at country level.

Figures 7.1 to 7.4 show urban and rural population between 1970 and 2000 and population projections between 2005 and 2050.

Figure 7.1. La Plata River Basin. Urban population by country (1970-2050)



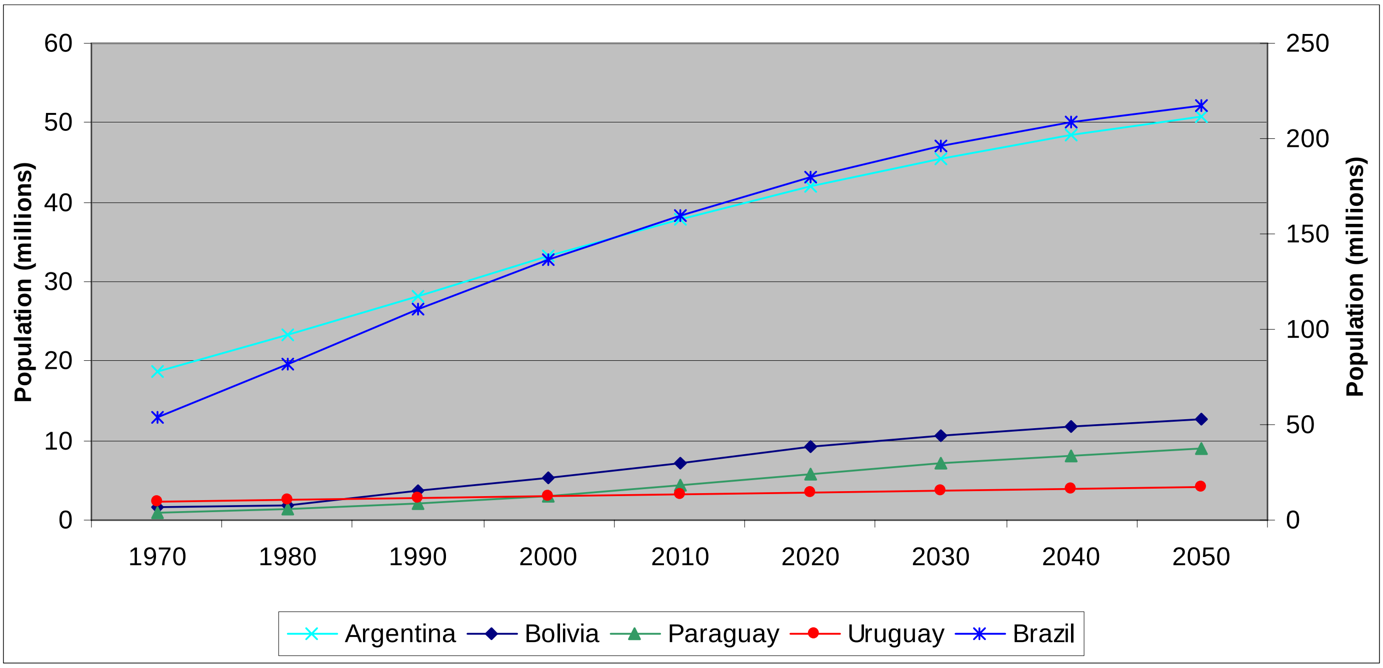
Source: CELADE, 2004

In absolute terms, the five countries of the La Plata Basin have increased their urban population between 1970 and 2000. Nevertheless, the variation of urban population shows a progressive fall in the growing rate, which is clearly observed for Argentina, Bolivia and Brazil. Paraguay and Uruguay, on the contrary, had a greater increase between 1980 and 1990, but it fell afterwards. In comparative terms, Bolivia and Paraguay show a more

[29] CELADE regularly publishes socio-demographic statistics of Latin America and the Caribbean, based on information provided by the census offices of the regional countries.

sustainable increase rhythm with the highest values of the basin (between a 47% and a 60%). It must be noted that these two countries have a more rural characteristic than the rest of the riparian countries. Argentina, Brazil and Uruguay, on the other hand, are countries which have had a high urban development in the decade 1970-1980. As from that period the population remains stable or with lower growing percentages.

Figure 7.2. La Plata River Basin. Inter-census variation of urban population by country (1970-2050)

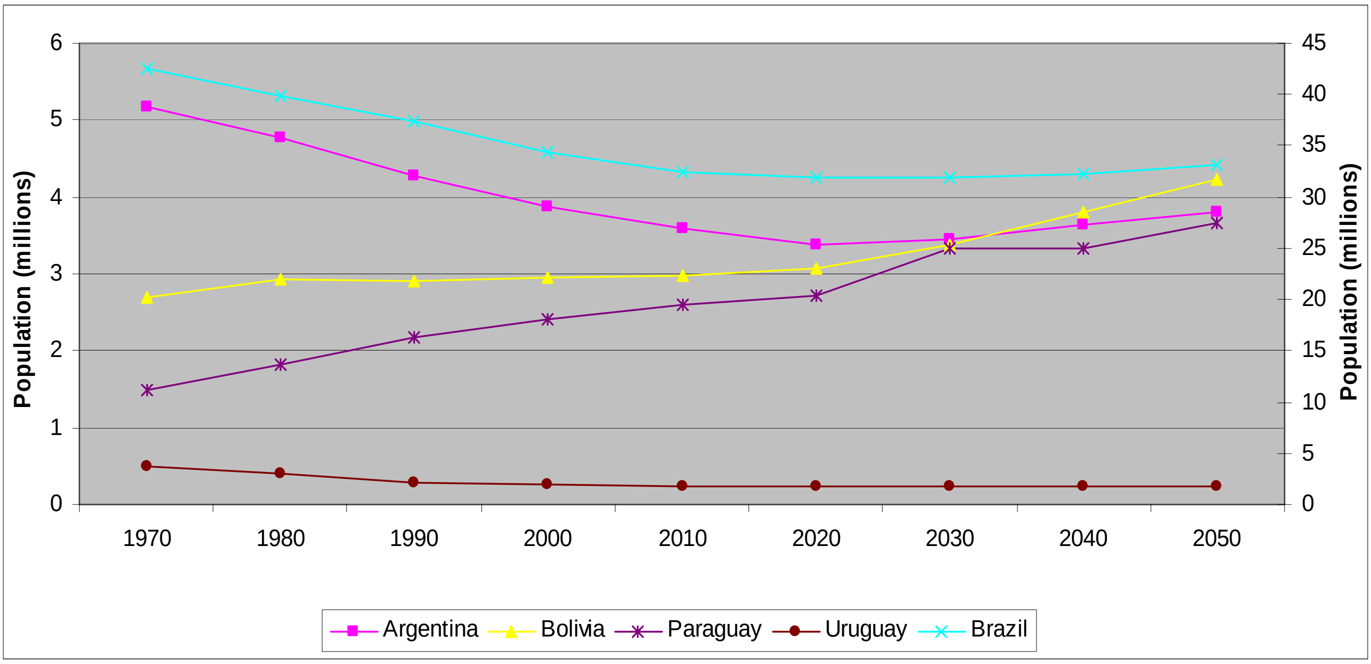


Source: CELADE, 2004.

Urban population projections, either in absolute or relative terms indicate that the process initiated in the last decades of the XX century in the five countries will continue, that is, a progressive diminution of the population growth rate. The same conditions observed till the 2000s will be maintained in the future decades: Bolivia and Paraguay will continue having the higher urban growth of the La Plata Basin.

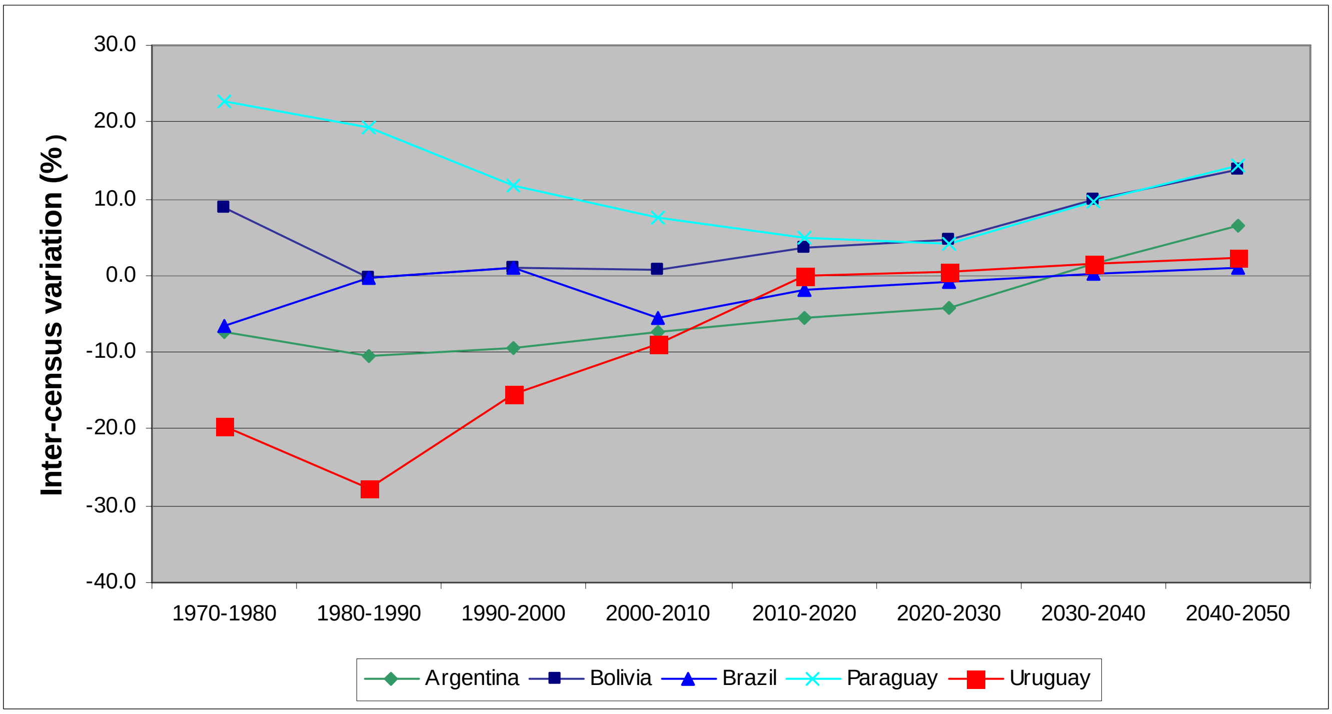
An outstanding condition of the five countries' rural population is the sustainable decrease either in absolute and relative terms. The three countries with higher urban profile (Argentina, Brazil and Uruguay) have also the highest decrease in their rural population. This situation is clearly observed in Uruguay, where this decrease reached almost 28% between 1980 and 1990. Although the variation in Paraguay and Bolivia is lower in the case of urban population, this indicator has still a slight tendency towards growing.

Figure 7.3. La Plata River Basin. Rural population by country (1970-2010).



Source: CELADE, 2004.

Figure 7.4. La Plata River Basin. Inter-census variation of rural population by country (1970-2050)



Source: CELADE, 2004.

A comparison between both indicators (urban and rural population) would conclude that in Argentina, Brazil and Uruguay the urban development was much more a consequence of a lost in rural population –through urban-rural migrations– than the urban and rural vegetative growth. In Bolivia and Paraguay, the vegetative population growth would explain the urban and rural increase and decrease much more than movements between country and city.

Finally, projections of rural population show that the five riparian countries would gain population. Countries with a progressive loss of their rural population during the last years of the past century (Argentina, Uruguay and Brazil) will switch this tendency towards 2030 and they will experiment a relative low increase in their rates. Meanwhile, Bolivia and Paraguay will show a progressive and sustained rural population increase, which have been decreasing along the last decades of the XX century.

7.3. Access to improved water supply and sanitation services in urban and rural settlements

Official data on drinking water and sanitation services supply in urban and rural settlements are not sufficiently disaggregated to apply the methodology explained in Annex I. On the other hand and considering only the national level, the National Censuses do not divide the water supply data between urban and rural settlements. For these reasons, a secondary source was considered, that is, a report on water supply services in the beginning of the XXI century produced by CEPAL/ECLAC. Table 7.1 shows access to water supply around 2000, meanwhile Table 7.2 shows the access to sanitation systems around the same year.

Table 7.1. La Plata River Basin. Access to improved water supply by country (as percentage of inhabitants) around 2000

Countries	**Urban areas**			**Rural areas**
	Household connection	**Easy access**	**Total**	
Argentina	72	13	85	30
Bolivia	87	6	93	44
Brazil	91	5	96	65
Paraguay	69	1	70	13
Uruguay	94	5	99	93

Source: Jouravlev, 2004.

As it is shown in the table, household connection in urban areas is comparatively better than in the rural ones, which a remarkable inequality in coverage values between both areas. Nevertheless, Uruguay is an exception because both in urban and rural areas the percentages are widely over 90% of the total population; the country also has the best rate of improved water access within the basin. Contrarily, Paraguay has only 13% of its rural population and 70% of the urban population with improved water access.

The urban areas of the riparian countries have generally better conditions as regards sanitation services: around a 90% of the urban population is covered, while only a 53% of the rural population has access to these services. In any case, the values show that the urban households connected to the sanitation systems are relatively few and that the easy access has a relatively important weight.

Table 7.2. La Plata River Basin. Access to sanitation services by country (as percentage of inhabitants), around 2000

Countries	Urban areas			Rural areas
	Household connection	Easy access	Total	
Argentina	55	34	89	48
Bolivia	45	37	82	35
Brazil	59	35	94	53
Paraguay	13	72	85	47
Uruguay	51	45	95	85

Source: Jouravlev, 2004.

Considering the sanitation services' situation in the country, the worst ones are observed in Bolivia and Paraguay. The first of them has the lowest sanitation access percentage in rural areas of the basin, whereas the second one has the lowest coverage in urban areas, considering household connection. Uruguay is the country with the best relative situation both in urban and rural areas; this is a result of a continuous expansion of the sanitation system along the country (see box 7.1).

7.3.1. Water loss due to leakages in infrastructure

The water sector in Argentina was one of the most developed in the region at the beginning of the XX century. The situation towards the beginning of 1990's had changed remarkably: Argentina ranked 14th among the top 20 countries in relation to access to municipal drinking water. In Buenos Aires Metropolitan Area, service quality had deteriorated considerably, with high levels of non-recorded water losses, among other problems. This situation changed again after the services were privatised, with a positive trend that started in 1993 –when the state-owned *Obras Sanitarias de la Nación*, OSN (Sanitary Works of the Nation) outsourced the service–, although in 1996 there was a reversion to the trend observed in 1993-95 (Abdala, 1998).

The water leakage percentage verified in Uruguay is equivalent to 47.7% of the total produced volume. If the regions included in the La Plata Basin are considered, the percentages vary between 46.2% (Montevideo Metropolitan Region) and 54.4% (North Region), 48.2% the Littoral Region and 50.5% in the South region. Water losses have slightly diminished between 1995 and 1998 and this tendency will continue in the future, according to the programme to reduce physical and commercial losses. According to studies carried out by *Obras Sanitarias del Estado*, OSE (State Sanitary Works), approximately 50% of the total losses correspond to commercial leakages (Gobierno de la República Oriental del Uruguay, 2001).

Box 7.1. Expansion of sanitation coverage in Uruguay

Obras Sanitarias del Estado, OSE (State Sanitary Works) is in charge of the sanitation services provision in Uruguay. Through the last years of the XX century and the first ones of the XXI century, OSE has been extending the sanitation services coverage using the existing net. As part of this extension plan OSE requests to the Uruguayan intendancies the strictly fulfilment of the Law in two key aspects: the obligatory connection to the sanitation network –when it exists– by the front of the houses and the separation between pluvial and waste waters (von Cappeln *et al.*, 2002).

Figure 7.5. Works on sanitation coverage in Uruguay

Source: http://www.montevideo.gub.uy/ambiente/

These measures will be complemented with the modernisation of the plants of effluents' treatment and the extension of the coverage to new urban zones. This way, OSE not only intends to supply the population with a basic service, but also mitigates pollution problems related with improper discharges and prevents problems related with waterborne diseases.

Some reports indicate that by the end of July 2001, OSE had around 27,000 idle connections in the interior of Uruguay. In these cases, population preferred to use their cesspools because the local municipality performs the cleaning without any cost (von Cappeln *et al.*, 2002).

Generally, the reports point out the difficulties to measure water losses in the riparian countries of the La Plata Basin. Box 7.2 shows a case study in Brazil.

7.4. Poverty in urban and rural settlements

The world financial crisis of 1998-1999 especially affected the Southern Cone countries with important recesses in the GDP. These recessive circumstances had direct consequences over the general increases of the unemployment levels and the decreases of the occupation rates. The diminution of worked hours was accompanied by the deterioration of salaries in real terms. Both factors contributed to raise the poverty in most Latin-American countries, and especially those integrating the Mercosur (Argentina, Brazil, Paraguay and Uruguay) and Chile. Table 7.3 shows the situation regarding poor and indigent households in both urban and rural areas of the riparian countries of the La Plata Basin.

The evolution of poverty and indigence between 1999 and 2001/3 was heterogeneous in the basin. Some of the countries had significant advances in the reduction of these phenomena, while others had important recession. In this last group Argentina and Uruguay were severely affected by a severe economic crisis at the beginning of the XXI century. In fact, poverty in Argentina –and specifically in Buenos Aires Metropolitan Area– had descended from 21.2% in 1990 to 19.7% in 1999, and then, duplicated to 41.5% in 2002. The tendency of the indigence was even more recessive, because it triplicated, from 4.8% in 1999 to 18.6% in

2002. After a diminution from 17.9% to 9.4% during the nineties, poverty in Uruguay increased six percentage points in 2002. Nevertheless, its rates of poverty (15.4%) and indigence (2.5%) are the lowest of the La Plata Basin (CEPAL, 2004 c).

Box 7.2. Difficulties measuring water loss in Brazil

A research done by professionals of the University of Brasilia points out the existing difficulties in Brazil to measure water losses. In general, the existing measurement systems regard all the unused volumes as losses in distribution, without the existence of an effective classification between real losses (due to physical problems in the networks) and apparent losses. The low feedback obtained in the research for real and apparent loss volumes shows the scarce knowledge about water losses, both in smaller –where identification and measurement of the different types of losses would be easier– and in larger systems. The leading service provider companies within the national scene do not know the differentiation level of their losses (de Miranda & Koide, 2003).

Another identified problem has to do with the indicators adopted for measurement, like the "invoicing loss index", the most frequently and traditionally used in Brazil. Although this indicator has a name that implies losses from the financial viewpoint, it is used in practice to assess water losses. Researchers point out a mistake here, since the invoiced water volumes are usually higher than the consumed water volumes owing to the invoicing criteria adopted almost unanimously in the country. In fact, data from year 2002 indicate that 19 state-owned companies (73% of the sample) have an invoiced volume higher than the consumed one, regardless of micro measurement levels.

As a valid example for the La Plata Basin, the invoiced volume is 10.4% higher than the consumed one in the case of the state-owned company of São Paulo (SABESP) and 16.9 % higher in the case of the state-owned company of Paraná (SANEPAR) (de Miranda & Koide, 2003).

This is the reality for most of the systems in Brazil, which hampers advance in the performance assessment in the field of water losses since it is not possible, at least in the short term, to use indicators that may reflect real losses separated from apparent ones. It is observed that, in the present scene, it is only possible to use total loss indicators (de Miranda & Koide, 2003).

The urban areas of Bolivia and Asunción Metropolitan Area –in Paraguay– suffered in the last years an increase of around 3 percentage points in the poverty rates and a lower percentage in the indigence ones, switching the tendency observed in the period 1990-1999. The incidence of poverty and indigence in rural areas is still higher than in urban areas in all the riparian countries (CEPAL, 2004 c).

Table 7.3. La Plata River Basin. Poor and indigent households (urban and rural) by country. Years 2000-2001

Countries	Poor Households (%)			Indigent Households (%)		
	Total	Urban	Rural	Total	Urban	Rural
Argentina*	---	35	---	---	14	---
Bolivia*	56	45	73	32	17	56
Brazil**	30	27	45	10	8	21
Paraguay**	52	42	65	27	15	41
Uruguay*	---	9	---	---	1	---

Note: * Data of year 2002; ** Data of year 2001
Source: CEPAL, 2004 c

The main issues identified in Uruguay concerning the linkage between water and poverty in the following areas: a) sewerage network coverage; b) sewage treatment; c) urban drainage; d) urban and suburban flooding. In most cases poor people are the most affected because they settle in marginal zones, floodplains or areas lacking basic infrastructure. Problems related to irregular settlements (slums) have been intensifying through the last two decades (von Cappeln *et al.*, 2002).

Bolivia is in the opposite situation. In 2001, around a 60% of the Bolivian population was in precarious living conditions, according to the Unmet Basic Needs index (UBN). The regional, urban and rural differences are very important with a remarkable incidence of rural poverty and especially extreme poverty. Potosí is the Bolivian department –in the La Plata Basin– showing the worst indicators of poverty in the country, with around an 80% of the population living in UBN conditions and 71% with lacking in drinking water and sanitation services issues. Meanwhile, in Tarija Department the situation is quite different, with an outstanding poverty reduction partially related to a better coverage of drinking water and sanitation services (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

In Paraguay, the number of poor people increased in 100,000 inhabitants in the last years of the XX century. Poverty affected in different ways according to the residence area; thus, the highest percentage of poor people (57.4%) is located in rural settlements (Gamarra Lovera, 2002).

In Argentina, the successive crises in the nineties resulted in a null or inexistent economic growth. The immediate consequence was the massive destruction of employments and an increasing deterioration of the social situation. In the sanitation sector, the private concessionaires made inversions in those areas where people with high purchasing power live, while the poorest remained without the service. National, provincial and municipal governments do not have enough resources to supply this population; therefore, the solutions that the governments have been implementing do not cover the existing demand (Calcagno, 2001).

Brazil does not escape to this general tendency. The country has not only an increase in the number of people below poverty line, losses in employments and decreases in salaries, but it also has an amplification of the gap between the richest and the poorest. According to the

Brazilian branch of the *Cooperative for Assistance and Relief Everywhere Inc*, CARE[30], Brazil is one of the two first countries in the world with social inequality (CARE, 2005).

7.4.1. Public health issues[31]

The health national ministries are in charge of defining political and strategic guidelines for the sector in all five countries of the basin. Generally, the goals of these programs are similar because all of these seek to guarantee access to health for everyone, focusing on the highest risk groups (children, the elderly, indigenous communities) and encourage health promotion and prevention.

In Argentina, the *Ministerio de Salud*, MSAL (Ministry of Health) has taken a commitment with entities in the health sector within the framework of the *"Mesa del Diálogo"* (Dialogue Table), in which a number of objectives are set towards improving coverage and health quality. Among said objectives, the following strategies and actions are worth highlighting:

- Reduce sanitation and epidemiologic risks of the population as a whole, especially among the most vulnerable groups.
- Improve accessibility to health services.
- Define adequate tools to solve sanitary emergency (Ministerio de Salud y Ambiente de la Nación Argentina, 2002).

In Bolivia, the central goal of the *Ministerio de Salud y Deportes*, MSP (Ministry of Health and Sports) is to consolidate health as a right without fragmenting problems or isolating them from their social context. It intends to encourage promotion, prevention and healing within an atmosphere of integrity, bearing in mind that defending health requires not only specific medical action but also deep social changes. In this context, the creation of the *Sistema Nacional de Salud* (National System on Health) provides for the rationalisation and optimisation of Primary Health Care resources, one of which is basic sanitation (Ministerio de Salud y Deportes de la República de Bolivia, 2005 a).

In Brazil, the national health policy is based on the Federal Constitution of 1988, which sets out the principles and guidelines for the delivery of health care in the country through the *Sistema Unico de Saúde,* SUS (Unified Health System). Under the Constitution, the activities of the federal government are based on multiyear plans approved by the National Congress for four-year periods. The main goals of the health sector are the improvement of the overall health situation, with emphasis on reducing child mortality rates, and a political-institutional reorganisation of the sector, with a view to enhancing the operating capacity of the SUS (PAHO, 2004 b). These goals were included in the new *Plano Nacional de Saúde - Um Pacto pela Saúde no Brasil,* PNS (Health National Programme – A Pact for Health in Brazil) approved in December 2004. Besides, this plan promotes:

- strengthening the management of the *Sistema Nacional de Vigilância em Saúde* (National Health Surveillance System), in all three branches of the government, in the

[30] CARE is a international humanitarian organisation fighting global poverty.
[31] Information on public health, water related diseases and mortaliy rates can also be found in Chapter 5, Water and Health.

areas of epidemiologic, sanitary and environmental surveillance, in order to broaden its capacity to analyse health situations and respond to the needs of the population;
- reduce morbidity and mortality caused by diseases and their consequent problems by means of intensifying individual and collective preventive and curative actions, taking into consideration both local and regional diversities as well as those groups or segments of the population that are most exposed (Ministerio da Saude, 2004).

On the other hand, the experience of the *Fundação Nacional de Saúde,* FUNASA (National Health Foundation) clearly integrates basic services supply and health care. This task is done in coordination with the municipalities in order to develop health and sanitation coverage in the interior of the country. To start this project, *Serviço Autônomo de Água e Esgoto*, SAAEs (Water and Sewer Autonomous Services) were created, which are institutions independent from the municipalities, both at an administrative and financial level (FUNASA, 2005).

In Paraguay, the National Constitution of 1992 states that health is a fundamental right and entrusts the State with its protection and promotion in the interest of the community (PAHO, 2004 a). The *Ministerio de Salud Pública y Bienestar Social* (Ministry of Public Health and Social Welfare) has been developing a series of sanitation programs, including general public services, public health, environmental sanitation, eradication of vectors, science and technology. It is also the authority of the Sanitary Code (Monte Domecq, 2004).

In 2003, the national government has defined the so-called National Health Programme for 2004-2008. The following are some of the goals set by the program (Ministerio de Salud Pública y Bienestar Social del Paraguay, 2003):

- decrease mother-infant mortality and morbidity rates;
- facilitate access to quality health services to disadvantaged populations;
- prevent and control environmental risks;
- increase epidemiologic vigilance in order to ensure control and prevention of prevalent, emerging and re-emerging diseases, avoiding the outbreak of new diseases;
- decrease prevalence and incidence of chronic and degenerative diseases; and
- improve care in health services.

In Uruguay, the *Ministerio de Salud Pública* (Ministry of Public Health) established five major goals for 2000-2005:

- strengthen the management of public and private health care institutions.
- adapt the supply of available services to the epidemiological characteristics and needs of the population.
- make health care coverage universal by facilitating access and care at all four levels of complexity.
- enhance service quality at all four levels of complexity.
- rationalise the use of services at Institutes of Highly Specialised Medicine.
- promote participation of service users and health care institutions to be able to solve problems within an atmosphere of trust and respect for the rights of citizens (PAHO, 2004 b).

7.4.1.1. Occurrence and frequency of water related diseases

There is no data linked to the occurrence and frequency of water related diseases in rural and urban areas. Nevertheless, the percentages of registered cases are estimated higher in rural areas compared with urban ones. On the other hand, there exist general data and reports about water related diseases in the major metropolitan areas of the basin, which will be mentioned below together with others considerations about the issue in the riparian countries.

Major water-borne diseases in the La Plata Basin are diarrhoea, malaria, dengue and cholera. Other diseases of relative less importance are yellow fever, leptospirosis and leishmaniasis. The main causes of the occurrence of cholera, diarrhoea and dengue are the lack of or the precarious provision of safe water and of systems for the elimination of excreta, among others. The increase of the pathologic processes is originated by the precarious living and environmental conditions, being the poor people the most vulnerable to these diseases. In fact, improvements in the sanitation services supply lead to considerable improvements in health indicators. Table 7.4 shows the recorded cases of water-borne diseases between 1998 and 2005, by country.

Table 7.4. La Plata River Basin. Cases of water-borne diseases by country (between 1998 and 2005)

	Argentina	**Bolivia**	**Brazil***	**Paraguay**	**Uruguay**
Diarrhoea	951,480 (2003)	315,786 (2005)	260,000 (2002)	41,450 (1999)	n/d
Cholera	12 (1998)	467 (1998)	753 (2000)	4 (1996)	---
Malaria	122 (2003)	23,552 (2005)	5,514 (2003)	1,392 (2003)	90 (2003)
Dengue	135 (2003)	4,095 (2005)	21,913 (2004)	148 (2005)	---
Leptospirosis	201 (2004)	n/d	1,353 (2003)	n/d	20 (2002)
Leishmaniasis	748 (2002)	1,735 (2000)	7,633 (2003)	86 (2004)	---
Yellow fever	---	56 (2005)	62 (2003)	---	---

Notes: *Data for the states of the La Plata Basin; n/d, no data; ---, no cases recorded.
Sources: PAHO, 2004 a; Ministerio de Salud y Ambiente de la Nación-OPS, 2005; Sistema Nacional de Vigilancia Epidemiológica de Argentina, 2003; Sistema Nacional de Información en Salud de Bolivia, 2005; Ministerio da Saúde, 2004; Ministerio de Salud Pública y Bienestar Social del Paraguay, 2005, Ministerio de Salud Pública de la República Oriental del Uruguay, 2002.

The following paragraphs summarise the incidence of each water-related disease in the basin.

- Diarrhoea

This is the most frequent water-borne disease in Argentina, with an incidence of up to 0.067 cases per year in children under 5 years of age (Castro, 2000). In Paraguay, it was the third leading cause of outpatient consultations in health services of the *Ministerio de Salud Pública* *y Acción Social* (Ministry of Public Health and Social Welfare). The mortality rate for acute diarrhoeal disease (ADD) in the general population was 8.3 per 100,000 in 1996 and 6.4 per 100,000 in 1999. ADD was the second leading cause of death in children aged 1 to 4 (15% of all deaths in that age group) (PAHO, 2004 a).

- Cholera

The regional cholera epidemic of the 1990s affected Argentina, Bolivia, Brazil and Paraguay. In Argentina, most of the cases occurred in the Northwest region and the case reports showed a seasonal epidemic pattern, according to which, the number of cases increases in the summer (PAHO, 2004 a). In Bolivia, incidence has declined since 1995, after a period of 814 deaths caused by cholera (PAHO, 2004 a). The same happened in Brazil, where the lowest number of cases was recorded in 2000 and in Paraguay, where no cases have been reported since 1997 (PAHO, 2004 a).

- Malaria

The disease is actively transmitted in 75% of the Bolivian territory (where half the country's population lives). It also has a great incidence in Brazil, where it is the major vector in the Amazonian states. In some Brazilian states of the La Plata Basin, malaria cases have increased in the early 2000's (Secretaría de Vigilãncia em Saúde, 2005 b). In Paraguay, an important epidemic was detected in the early 2000's. In Argentina, malaria occurred most frequently in risk areas in the province of Salta, bordering Bolivia. In the Northeast, some occasional epidemic episodes were reported (PAHO, 2004 b).

- Dengue

Brazil shows a relatively worse situation regarding dengue fever. Nevertheless, in the first six months of 2005 incidence has decreased by 28.5% compared with 2004 (Secretaría de Vigilãncia em Saúde, 2005 a).

In Argentina, the vector has been detected in 17 of the 24 jurisdictions of the country. During the first three months of year 2000 cases of classical dengue fever reappeared in the indigenous communities located in the NW. During the summers of 2000 and 2001, no epidemic outbreaks were reported. However, isolated cases –imported from neighbouring countries– continued to be reported.

The re-emergence of dengue was detected in Salta in 1997, where an outbreak of dengue fever type 2 occurred later in 1998. During 2000 a dengue type 1 outbreak in the Northeast of Argentina was reported, specifically in Misiones and Formosa provinces. In 2001 no autochthonous transmission was detected and in 2002 cases of dengue type 1 were reported in Salta Province. Autochthonous transmission was detected in Misiones, Formosa, Jujuy and Salta provinces. Other jurisdictions of the country have reported imported sporadic cases.

In spite of the fluent traffic of population across the borders, climate factors favouring the vector's proliferation, viral circulation of serotype III in bordering populations of Bolivia, Paraguay and Brazil, outbreaks in neighbouring populations such as Foz de Iguaçú (Brazil), it was possible to prevent autochthonous cases in border areas and control the outbreak in Salta. Dengue serotype III first appeared in an imported case in Misiones Province in 2002 (Dirección de Epidemiología de la República Argentina, 2002).

In Bolivia, classic cases of dengue have been documented since 1987. In 1999, 27 cases of classic dengue were identified and in 2000, 80 cases were reported. In 2003 almost 1,500 suspected cases were registered and 128 were confirmed (OPS, 2003).

Dengue transmission was detected in February 1999 in Paraguay, and an epidemic ensued, affecting a large part of the country. The country undertook an intensive campaign to combat the epidemic, enlisting the participation of institutions and organised community groups. Nevertheless, many Paraguayan cities still have indexes of *Aedes* that are compatible with transmission of dengue (PAHO, 2004 b).

Although there is no autochthonous transmission of dengue in Uruguay, a potential problem has been posed since the reintroduction of the *Aedes aegypti* mosquito, which may transmit dengue (PAHO, 2004 a), mainly in the cities of Fray Bentos and Mercedes (PAHO, 2004 b). In 2002, 11 cases of dengue were registered throughout the country, all of which were travellers who had been in Brazil 15 days prior to the onset of the symptoms. If the number of households surveyed is compared with the number of positive cases, it is observed that, although the rates are kept low, the vector is increasingly expanding in the territory, which makes the fight against the disease both difficult and expensive (OPS, 2003).

- Leishmaniasis

In Argentina, the endemic area of this disease comprises the Northern provinces, which are either totally or partially included in the La Plata Basin: Salta, Jujuy, Tucumán, Formosa, Chaco, Santiago del Estero, Misiones and Corrientes. In 1998 over 1,000 cases were reported, most of which caused by an epidemic outbreak in Salta and Misiones. Since then, a significant decrease in the number of cases was observed until 2001, when 144 cases were reported, 84% of which were detected in Chaco, Salta and Misiones provinces. In 2002, another outbreak of the disease was recorded, claiming 748 cases, with foci along the Bermejo River Basin and its influence area. Salta, Formosa, Chaco and Jujuy reported 96% of all cases recorded in 2002 throughout the country (Dirección de Epidemiología de la República Argentina, 2002).

In Brazil, the American tegumental leishmaniasis has expanded its contagion area as compared to previous years when it was restricted to Amazonian states. In 2004 all the states of the Federation present autochthonous cases of the disease. According to the *Ministério da Saúde* (Ministry of Health), this may be due to difficulties met in controlling the disease because of the constant changes in vectors and epidemiologic patterns of transmission, mainly associated with the human action on nature (Secretaria de Vigilância em Saúde, 2004).

- Leptospirosis

In 2001, 175 cases were reported in Argentina, which shows an increase of over 200% as compared to the previous year[32]. Most of the cases (89%) were recorded in Buenos Aires Province, 36% in Santa Fe Province and the remaining 13% distributed in the provinces of Entre Ríos, Misiones, Córdoba, La Rioja and Jujuy (Dirección de Epidemiologia de la República Argentina, 2002).

[32] The source pointed out that it is necessary to investigate in order to determine whether or not cases had been under-reported prior to year 2001 or if there was a real increase in the transmission of the disease during that year (Dirección de Epidemiología de la República Argentina, 2002).

In Brazil, an annual average of 3,324 cases was recorded between 1994 and 2003, with an average case-specific mortality topping 10%. The most affected age group is adults between 20 and 49 years of age and most cases are associated with poor living conditions and lack of sanitary infrastructure, mainly in the household. The disease appears both in urban and rural areas. However, most reported cases are focused in capital cities and metropolitan regions. Floods and heavy rains make human contact with water contaminated by excreta of rodents more likely, thus favouring contagion (Secretaria de Vigilância em Saúde, 2004).

Between 1999 and 2002, there were around 120 suspected cases of leptospirosis in some departments in Eastern and Central regions of Uruguay, of which only 35 were confirmed. In addition, in 2002, the number of suspected cases increased (OPS, 2003).

In 2002, a few cases of this disease were reported in Montevideo Metropolitan Area, more precisely, in flood-stricken slums (Pignataro, 2002).

- Yellow fever

The urban form of this disease has disappeared in Brazil and only its wild form remains. Anyway, the presence of *Aedes aegypty* in the urban area of a great part of the territory poses potential threats to reintroduce urban yellow fever (OPS, 2003).

In the La Plata Basin, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul states are part of the disease's transition area, while the "unscathed area" comprises the Southern and Southeastern regions, where there is no proven circulation of the virus. The last big epidemic affected Minas Gerais State in 2003 (Secretaria de Vigilância em Saúde, 2004).

Thanks to the progressive increase in vaccination, the incidence of yellow fever in Bolivia has decreased in 2003 versus previous years, mainly in the endemic areas of the disease (OPS, 2003).

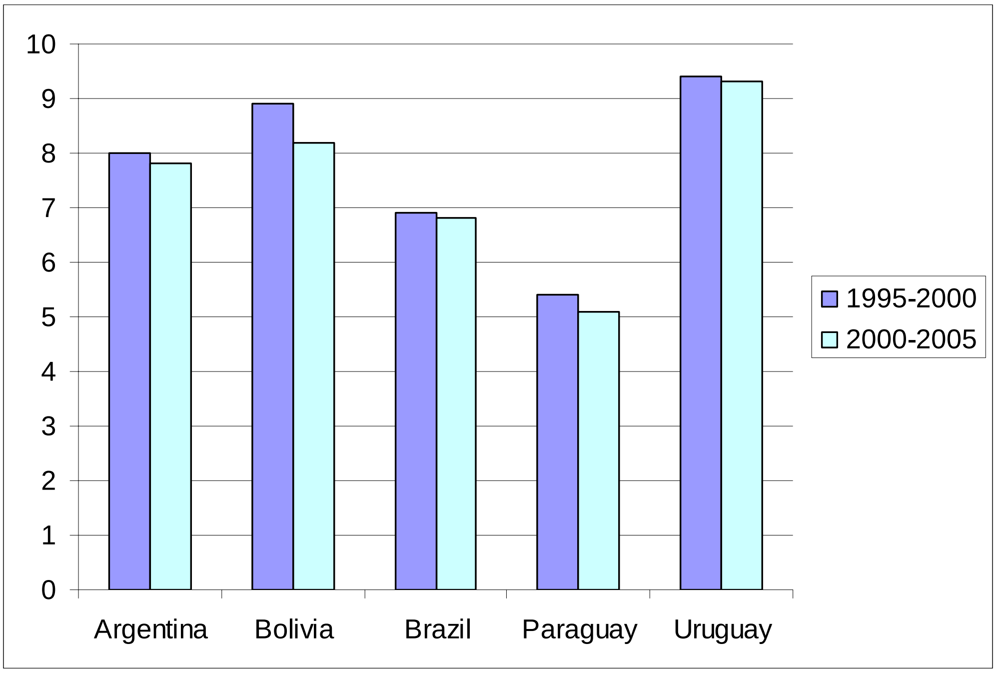
In Paraguay, the disease had practically disappeared. However, in view of the cases reported in Bolivia, a series of preventive measures were taken to avoid the reintroduction of the disease (OPS, 2003).

7.4.1.2. Mortality in urban and rural areas

Since there is no information on mortality rates in urban and rural settlements, the total mortality rate by country is presented in Figure 7.6

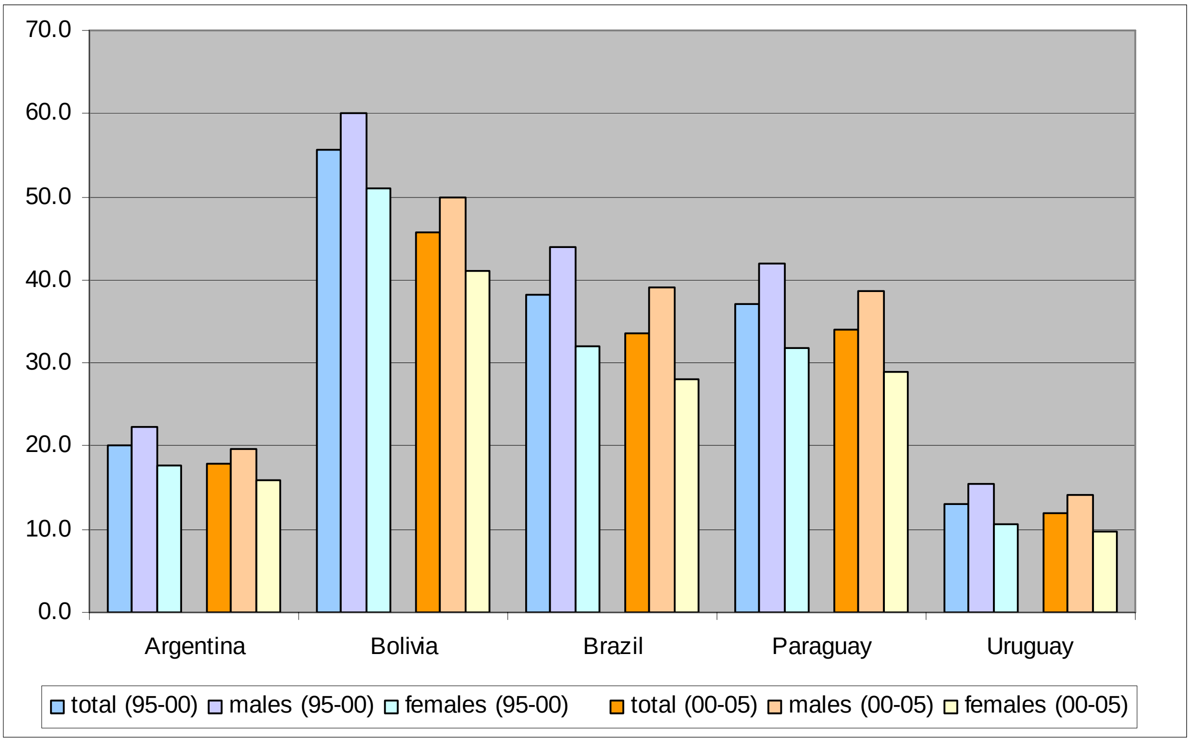
The general mortality rate shows little variation among the riparian countries, with a maximum of 9.4 in Uruguay and a minimum of 5.4 in Paraguay registered between 1995 and 2000. There is a slight improvement in the 2000-2005 period, with a maximum of 9.3 in Uruguay and a minimum of 5.1 in Paraguay. In the rest of the countries, the mortality rate decreased in a similar percentage too.

Figure 7.6. La Plata Basin. Mortality rate by five-year periods (1995-2005)



Source: CEPAL, 2004 a

Figure 7.7. La Plata River Basin. Infant mortality rate by gender and country. Five -year periods (1995-2005)



Source: CEPAL, 2004 a

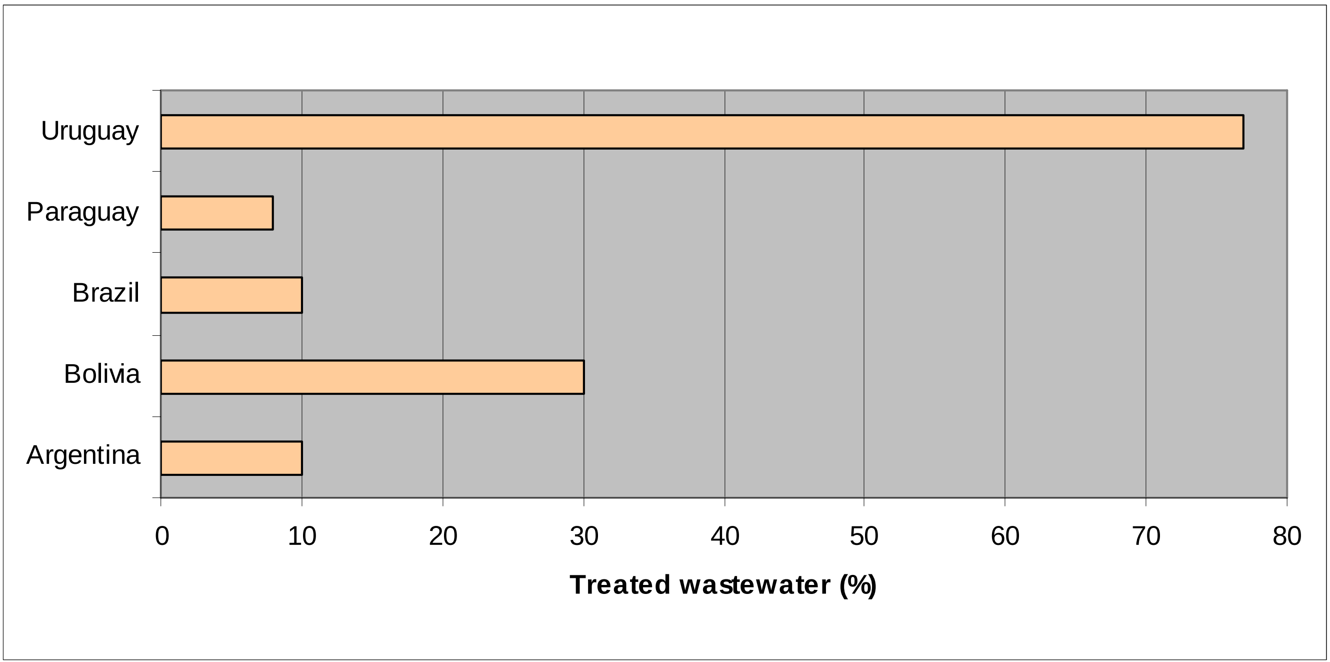
Infantile mortality rate is another indicator used to illustrate the links between living conditions and provision of water and sanitation services. Figure 7.7 shows the Infant mortality rate in the basin[33].

Infant mortality rate reaches very high levels in Bolivia, with a 55.1 rate in the 1995-2000 period. There is an improvement during the 2000-2005 period, but it is still a worrying mortality rate. Intermediate situations can be seen in Paraguay and Brazil (with 37 and 38.1 mortality rates, respectively), whereas the lowest positions –and, therefore, better health situations– are held by Uruguay and Argentina. Again, in all the cases the indicator has improved there is an indicator improvement in the 2000-2005 period. These numbers are consistent with the distribution of drinking water and sewage services described earlier in this chapter.

7.4.2. Contamination from wastewater discharges

The contamination of surface water and aquifers in the basin is mainly related to domestic and industrial wastewater discharges. As Figure 7.8 shows, the proportion of treated wastewater discharges is very low in all countries, except in Uruguay.

Figure 7.8. La Plata River Basin. Treated wastewater by country (as percentage of total discharges). Year 2000



Source: Castro, 2000; Fonseca *et al*, 2000; Orozco *et al.*, 2000; Salvatella Agrelo, 2000; Texeira *et al.*, 2000

[33] Although child mortality rate are disaggregated in sub-country administrative units (provinces, municipalities, departments), it is not possible to apply the same methodology used in other demographic, social and economical variables throughout the document (see Annex I).

Generally, the urban areas are those mainly affected by pollution from wastewater discharges. That is the case of São Paulo Metropolitan Area, in Brazil, which is the most important urban concentration in the La Plata Basin and it is located on the Upper Tietê River Basin, one of the most important Brazilian tributaries of the Paraná River. The river system is anoxic due to the discharges of untreated industrial effluents and sewage. The absence of fish and the emission of disagreeable odours for much of the year have turned it into a sewage dump. The Tietê River receives permanent wastewater discharges, at a rate of about 40 m^3/s, which represents 60% of the river's mean dry-season flow. This pollution affects 8,000,000 people and it is the cause of water quality deterioration in the reservoirs located downstream (UNEP, 2004).

Other Brazilian cities with this kind of problems are Brasilia and Curitiba. Population of Brasilia dumps the treated effluent into the Paranoa Lake, which exhibits water quality problems. On the other hand, Curitiba City discharges its loads without treatment into the Iguazú River (UNEP, 2004).

The Buenos Aires Metropolitan Area, in Argentina, concentrates the most important part of the Argentinean industries. A great amount of little and medium industries –distributed randomly into residential areas– consume great quantities of water and discharge important amounts of organic and chemical effluents to the rivers around the area. The pollution levels are extremely high, and some of the rivers could be considered as open sewers (Calcagno, 2001). These are the cases of Riachuelo River and the coastal strip of the La Plata River. In the latter case, the situation is worse since the pollution jeopardizes the water intake of Buenos Aires city.

The urban settlements in Bolivia have similar problems. In these areas, one part of the industrial and domestic wastewater discharges are transported through sewers towards the rivers and other parts are directly connected to rivers, gullies and small water courses, especially those coming from precarious settlements (slums) or areas without sanitation service. In rural areas, where the sanitation service coverage is very low –scarcely a 35%–, the situation is worse. The domestic wastewaters are deposited directly in watercourses or through transport and infiltration processes into the groundwaters (Unidad de Desarrollo Ambiental Sustentable, 2002).

Although the sanitation coverage is very good and the wastewater treatment level is high, pollution is still a problem in the urban centres of Uruguay, especially in the Montevideo surroundings. Discharges of organic products from residences, sewers and industries persist in the streams of the city –Miguelete and Pantanoso–; meanwhile, inorganic contamination has stabilised due to a decrease registered in industrial activity. Some aquifers located in the South have also pollution indexes which could modify their aptitude for irrigation or drinking water supply (von Cappeln *et al.*, 2002).

In Paraguay, finally, the pollution due to wastewater discharges in watercourses is increasing. However, pollution levels are still low, considering the relatively low economic activity, the low demographic density and the relatively modest dimension of human settlements, all together with the high capacity of dilution of Paraná and Paraguay rivers. So far, there are important, but mitigable pollution problems in the sub-basins of Asunción and Ypacarai Lake, which receive great quantities of organic matter and nutrients from agro-industrial and domestic activities (Gamarra Lovera, 2002).

7.4.2.1. Discharge load by sector (industrial, domestic, agriculture)

Abundant secondary information describes the contamination problems related to wastewater discharges from the industrial, domestic and agricultural activities. This information complements the description included in item 7.4.2, which introduces the contamination issue due to lack of wastewater treatment systems. This item shows detailed information on high levels of BOD and COD detected in most of the rivers of the La Plata Basin.

The Paraná River and its main tributaries receive all types of contaminants, but mostly those associated to urban-industrial activities. For instance, high concentrations of heavy metals have been found in São Paulo Metropolitan Area; these concentrations exceed the CONAMA "Guidelines for Freshwater Aquatic Life". Concentrations of zinc, mercury, copper and lead – exceeding the acceptable levels– have been found in two Paraná River tributaries (Tamanduateí and Pinheiros). São Paulo has also problems with water treatment, due to the excessive algae blooms in the Billings-Guarapiranga reservoirs[34], one of the water suppliers of the city. This causes a high concentration of phosphorous and chlorophyll a and, consequently, generalised eutrophic conditions. The series of reservoirs built in the Middle Tietê River also receives discharges from sugar cane processing plants, besides the discharges from São Paulo City, located upstream. A similar stress is found in Curitiba, where only 29% of the population is connected to the sewage network (UNEP, 2004).

The agricultural basins of the Paraguayan departments of Itapua and Alto Paraguay –which are affluent to the Paraná and Paraguay rivers–, produce pressures of different origins: mainly pesticides and nitrogen nutrients. Meanwhile, domestic wastewater discharges generate pollution by biodegradable organic substances, inorganic salts and sulphates –from the utilisation of soap and other cleaning products– and compounds present in excreta. Finally, the industries with major contribution to the pollution of waters in Paraguay are those devoted to manufacture beer and soda drinks, which produce high organic matter, nitrogen and phosphorus. Besides, high concentrations of heavy metals (zinc, plumb and mercury) were detected in the Asunción Bay. The metallurgical activity and oil refineries are the main contributors of suspended solid to the rivers (Ministerio de Salud Pública y Bienestar Social del Paraguay, 1998).

Water quality in the Pilcomayo and Bermejo rivers (Bolivia) is good except near the human settlements. However, additional water pre-treatment is required since those rivers have increases in turbidity related to large sediment loads during the summer rainy season. Through the *Programa de Monitoreo de Agua* (Water Monitoring Programme) of the Tarija Department in Bolivia, high concentrations of arsenic, lead, cadmium, nickel, zinc, manganese, cyanide, phosphorous, iron and boron have been detected. Those concentrations were higher than the values allowed by the Bolivian environmental legislation (UNEP, 2004).

Asunción and Ipacarai Lake sub-basins –located in the Paraguay River Basin– are the two most contaminated areas in Paraguay. Compared with other areas in the country, these basins receive great quantities of organic matter and nutrients, mainly from agro-industrial and domestic activities (Ministerio de Salud Pública y Bienestar Social del Paraguay, 1998).

[34] The metropolitan system is fed from 8 major systems (Cantareira, Guarapiranga-Billings, Alto Tietê, Grande River, Claro River, Alto Cotia, Baixo Cotia and Riberão da Estiba). The Guarapiranga-Billings system supplies around 20% of the São Paulo Metropolitan Area's requirement (UNEP, 2004).

In relation to industrial and domestic discharges various problems were detected in the Uruguay River (von Cappeln *et al.*, 2002):

a) Salto City discharges untreated wastewater to the Uruguay River and sewage and chemical residues cause pollution in several areas;

b) A sewage collector was constructed in Fray Bentos City, but pollution problems still persist, since the wastewater treatment system is inefficient. Besides, the contamination by industrial and urban effluents in Gualeyguaychú City (Argentina) aggravates the problem;

c) A new sanitation network has also been constructed in Mercedes City, but some locations still remain without coverage and the discharges –mainly from paper manufacturers–, contaminate the Negro River;

d) Paysandú City dumps its effluents to the Uruguay River without previous treatment, with the consequent pollution. Nevertheless, a sanitation project –consisting in providing water treatment and networks– has been carried out, which will allow improving the present situation.

A large concentration of population and industries of Argentina and Uruguay extends along banks and nearby areas of the La Plata River, discharging waste and sewage waters from domestic and industrial origin into the river directly or indirectly, through tributaries and main open storm sewers. High concentrations of ammonium, nitrates and phosphates, as well as heavy metals, agrochemicals and biphenyl poly-chlorines have also been found. The highest bacterial concentrations occur within the 500 m from the coast, and decreases beyond 3 km. Microbiological parameters such as total coliforms and faecal coliforms exceed the values recommended by the US Environmental Protection Agency (EPA). In 1997, a geometric mean of about 12,000 faecal coliforms/100 ml was detected in the Riachuelo River. As a consequence, direct contact recreational activities are interdicted in many areas along the coast, which indicates that the impact associated to microbiological pollution, should be qualified between moderate and severe in this region (UNEP, 2004).

Phytoplankton higher concentrations occur near the coast, although they have been decreasing during the last 50 years probably due to chemical pollution. The analysis of the distribution of main algae species distribution and their ecological features help in identifying the areas where the human impact is higher, such as the mouth of the Luján and Matanza-Riachuelo rivers and the sewage discharge located at the South of Buenos Aires Metropolitan Area (UNEP, 2004).

Leach from illegal landfills in Buenos Aires Metropolitan Area impact on drinking water availability. In addition, Buenos Aires and Rosario (the third main urban area of Argentina) discharge untreated sewage and other wastes directly into the La Plata and Paraná rivers, respectively. Further, even when waste treatment is carried out –as in La Plata City–, only a minor fraction of collected sewage water is purified (UNEP, 2004).

Another contamination source in Argentina is agriculture. In this case, high concentrations of arsenic, fluorine and nitrates are found both in superficial and groundwater (Calcagno, 2001).

Severe pollution problems have been identified in several water supplies in Uruguay. In the Santa Lucía River Basin –which supplies water to 60% of the country's population– and in the Laguna del Sauce Basin, eutrophication reduces the quality of water to unacceptable levels causing water shortages for Maldonado and Punta del Este cities (UNEP, 2004). Watercourses in the south part of the country, near the capital –where almost half of the total population lives– have more critical contamination levels. Although the main industries of the country, –such as wool laundry, furs and leather processing and meat preparation– are highly pollutant, difficulties for an effective discharge control can be observed; meanwhile, other products are ignored by the official oversight (von Cappeln *et al.*, 2002).

7.4.2.2. BOD and COD levels

Data related with both BOD and COD indicators is scarce or unavailable. Nevertheless, some data from Brazilian areas of the international basins can be presented as an example of the status of the most important rivers (see Table 7.5). Generally, contamination due to high BOD and COD levels is restricted to specific areas within the La Plata Basin, which mostly coincide with the large urban settlements (São Paulo, Curitiba, Buenos Aires), as quoted in previous paragraphs. This shows the importance of the problems related to pollution in the urban areas of the basin.

Table 7.5. Brazilian areas of international basins. BOD and dissolved oxygen in water.

Rivers	**BOD (mg/l O_2)**		**Dissolved oxygen (mg/l)**	
	1993-97	**1998**	**1993-97**	**1998**
Paraná (at Foz do Iguaçu)	1	1	9	9.6
Iguaçu (at Iguaçu National Park)	1	1	9.2	9.6
Paraguay (at Porto Murtinho)	7	5	4.6	3
Uruguay (at Irai)	1	0.5	7.8	6.1

Note: Guide values of water sources for human consumption:
- CONAMA (1986): BOD 5 and COD ≥ 5
- CIC (1987)

Source: UNEP, 2004.

As already mentioned, the rivers which crosses São Paulo Metropolitan Area (Brazil) and the reservoirs suppliers of drinking water, are highly contaminated. In 1996 the BOD inputs into Billings Reservoir was estimated in 10.7 t/day. In the beginnings of 2000s, water was imported from neighbouring basins –at a rate of 33 m^3/s– since the Tietê River system has lost its water quality (UNEP, 2004).

A similar type of stress on water sources is found in Curitiba Metropolitan Area, in the Upper Iguazú River Basin, where the water quality is generally good. In this river, the potential pollution load is around 140 ton/day of BOD5. Only the 29% of the urban population is connected to the sewage network (UNEP, 2004).

Intense urban and industrial water uses and poor water quality cause severe impacts in a large area of the La Plata riverbank, where Buenos Aires Metropolitan Area is located. However, the concentrations of pollutants decline rapidly away from the riverbank. Oxygen demands (BOD and COD) show high values between the Riachuelo River and Punta Colorada. Dissolved Oxygen reaches the lowest values near the coast and the maximum about 3,000 meters off the coast. The main city sewer (located in Berazategui) drains over 20 m^3/s of a large part of Buenos Aires Metropolitan Area. The typical parameters of the sewage waters discharged into the La Plata River included daily average values of 120 mg/l of BOD and 310 mg/l of COD (UNEP, 2004).

A 10,000 m wide coastal fringe of the La Plata River is subject to a systematic monitoring, since it is the area where both main water uses –including domestic water supply– and major impacts on water quality take place. The distribution of the physic, chemical and biological water quality variables in the La Plata River depends, to a large extent, on hydrodynamic and meteorological conditions. In general, concentrations show a gradient decreasing from the riverbank.

In Paraguay, 194.5 mg/m^3 of BOD from industrial origin and 243.2 mg/m^3 from domestic discharges were registered in the 1990s. This last value was mainly associated with the discharges of two major urban settlements of the country, that are Asunción (8.3 mg/m^3 daily) and Concepción (194.5 mg/m^3 daily) (Ministerio de Salud Pública y Bienestar Social del Paraguay, 1998).

7.5. Effect of water-related natural disasters (floods, storms, droughts)

Floods are one of the main natural-related risks of the La Plata Basin. The floodplains of the main watercourses have been devoted to agriculture or cattle-raising. On the other side, almost all the cities have been grown over their flood risk prone areas, in a process which has started at the sixties. A great increase in the frequency of extraordinary floods was registered in the seventies; thus, the economic impacts also have increased. Generally, risk prone areas management programs in urban areas –inexistent sometimes– have not been effective to prevent the chaotic urban growth in the entire basin (Barros *et al.*, 2004).

In the riverbanks of the Paraná River and its tributaries many densely populated cities are frequently affected by riparian floods. On the other side, several cities suffer flooding due to urbanisation. This is the result of a totally inadequate urban drainage management policy, which tends to favour drain-off and not retention. The urban development and the soil waterproofing (due to households, roads, sidewalks and others), has reduced the underground drainage and the volume that does not infiltrate, flows along the streets and storm drains. This process has created an increase in the flood flow rate, which has risen as much as sevenfold compared with past flow rates (Tucci, 2004).

In the Upper Paraná River Basin, the most affected cities are located on the Iguazú riverbanks (União da Vitória, Porto União and Curitiba) and on the Tietê riverbanks (São Paulo Metropolitan Area). In rural areas, the risk of flooding increases due to the way the occupation of floodplains was made. Therefore, the unplanned settlement processes aggravate the natural hydrological variations and increase the damages. It is worth to mention that floods have been causing important economic damages in both urban and rural areas.

In the Middle and Lower Paraná Basins, Resistencia, Corrientes and Rosario cities have been affected by floods, strongly influenced by the El Niño event (Barros *et al.*, 2004). In April-

May 2003 Santa Fe city (Argentina) suffered one of the worst flooding of the whole Argentinean history, as a consequence of a Salado River overflow.

The Paraguay River has large floodplains and a slow runoff regime. As the Upper Paraguay Basin population is relatively small, the floods impact is not catastrophic as in the lower basin where various cities are affected, being Asunción one of them (Barros *et al.*, 2004). Floods associated with El Niño events had important consequences; during 1982-1983, there was an important flooding all along the Paraguay River, from the Pantanal. During the El Niño event of 1992-1993, the flood was registered from the city of Concepción and downstream (Gamarra Lovera, 2002).

The flood's impacts are also important in the Uruguay River, and mainly in its Brazilian sector. São Borja, Itaqui, Uruguaiana are the cities that have always been affected by floods; Alegrete, a city located on one of the Uruguay River tributaries has also been affected (Dias Coelho, 2004).

A very important flood took place in the Uruguayan sector of the basin in 1992. In that opportunity, the river had an inflow of 37,714 m^3/s to the Salto Grande reservoir (shared by Argentina and Uruguay); this was the maximum flow registered in the place since 1898 (von Cappeln *et al*., 2002).

It is worth to mention that the La Plata River bank and its major tributaries are affected by floods due to windy tides originated in the river. These tides are caused by strong winds from the south-southeast quadrant (locally known as "sudestadas") which pushes waters to the Argentinean bank of the river and increases its normal level. The higher "sudestada" was registered in April 15, 1940 (4.45 m) followed by November 12, 1989 (4.06 m); February 7, 1993 (3.95 m) and July 27, 1958 (3.85 m). In August 1986 floods affected the southern and eastern departments of the Uruguayan bank with around 16,000 evacuated people in the Santa Lucia River Basin, leaving 2,300 people without houses. Nevertheless, the worst flood in Uruguay happened in 1959, with 38,000 people evacuated in the centre-western part of the country and with damages which arouse to USD 39,000,000 (von Cappeln *et al*., 2002).

In general, the La Plata River Basin has not significant water deficiencies. Some low water periods have strong impacts in the great urban centres, and are related to the water supply to human consumption. This kind of problem appears because some of the main urban settlements are located in the tributaries' headwaters, which restrict the water availability, adding another issue to the poor water quality caused by pollution. São Paulo and Curitiba cities, for example, have this type of problem (Barros *et al.*, 2004).

In the rural areas, the droughts affect agricultural production, such as the case of Uruguay, where some surveys show that those events affect one area more than others. As an example, the 1988-89 droughts affected most intensely the Negro River and the Santa Lucia River basins than other basins of the country (von Cappeln *et al*., 2002).

7.5.1. Contingency plans[35]

All countries already have or are organising efforts to implement institutions which determine the warning system based on the information provided by the meteorological and hydrological

[35] See also chapter 9, "Managing Risks"

services at regional or national levels. Those institutions are the *Dirección Nacional de Protección Civil,* DNCP (National Directorate of Civil Protection) in Argentina; the *Viceministerio de Defensa Civil y Cooperación al Desarrollo Integral* (Vice Ministry of Civil Defence and Cooperation towards the Integral Development) in Bolivia; the *Secretaria Nacional de Defesa Civil,* SEDEC (National Secretariat of Civil Defence) in Brazil; the *Comité de Emergencia Nacional,* CEN (Nacional Emergency Committee) in Paraguay and the *Sistema Nacional de Emergencias*, SNE (National System on Emergencies) in Uruguay.

Box 7.3. Floods in Buenos Aires Metropolitan Area

Buenos Aires Metropolitan Area is located in the lower area of various inter jurisdictional and small basins (Matanza-Riachuelo, Reconquista, Maldonado, Medrano). The city has a great development of building and pavement areas, which does not match with the available capacity in the storm drain network, constructed in the first half of XX century. That is why the drainage system collapses as a consequence of severe storms –which occur more often lately–, causing a great impact on the population, their goods and the existing infrastructure.

Figure 7.9. Floods in downtown Buenos Aires

Source: http://www.clarin.com.ar

One of the most severe storms was registered on May 31, 1985, when 308.5 mm of rain fell down during 25 hours, at a rate of 42.5 mm/hour. That huge rain had catastrophic consequences in Buenos Aires due to floods. The extraordinary event affect 630,000 neighbours and one death by electrocution was registered too; 15,000 telephone lines were out of order, the gas provision was affected and the subway and train networks were interrupted; 68 high tension generators were out of service and several kind of problems were detected in the transport system and city accesses.

Other important rainfalls which affected Buenos Aires were on February 6, 1998 (40 mm/15 minutes) and on of January 24, 2001 (82.7 mm/hour). In all these cases, the consequences are similar to that of 1985: the paralysis of the city.

With regard to meteorological and extreme hydrological events prediction, Brazil shows an advantage in terms of forecasting, since the country has the capacity to predict intense rainfall events. Based on these products, operational meteorology centres in Brazil, civil defence secretariats of the states and the capital city determine hydrological warnings, based on criteria which vary from state to state. For example, São Paulo City has a high advanced hydrological warning system for the capital city only. This system employs trained staff, relies on advanced models, rain observations through radar and a hydrometeorological telemetric network, which transmits warnings (Marengo *et al.*, 2004).

In Argentina, the advantage is seen in the existence of the *Sistema de Alerta Hidrológico de la Cuenca del Plata* (La Plata Basin Hydrological Warning System), managed by the *Instituto Nacional del Agua,* INA (National Institute of Water). This system, born during the 1982-83 ENSO event, works for the Argentinean area of the La Plata Basin. The Warning System has had significant advances in forecasting and improved the responses during the floods produced since its creation. It also predicts water levels, which is important to plan navigation and harbour activities. The Warning System has got equipment and instruments of high technology, which enhance the information exchange in real time with the provinces and other national institutions (INA, 2005).

One of the weaknesses of the basin is regarding what are considered severe atmospheric phenomena. It is common the lack of data collection on extreme rainfall events and what is even more fundamental, the lack of common criteria to define what should be considered an extreme rainfall event or the definition of maximum discharge values or river water levels that could bring about intense flooding representing an extreme hydrological event. This last point is important, since, according to the criteria of mayors of big cities, hydroelectric system operators and the agricultural sector, the definition of extreme hydrological events varies. It also varies from country to country, which makes it difficult to draw comparisons and promote integration in the whole basin. There is also a lack of small-scale early warnings for vulnerable cities, such as São Paulo or Buenos Aires. The deterioration of existing warning systems and cultural deficiencies make difficult to handle this issue (Marengo *et al.*, 2004).

In Uruguay, the national legal framework attributes jurisdiction to municipal governments to determine land qualification for prospective urbanisation. In this sense the Municipal Organic Law 9,515 of 1935, and the Populated Centres Law 10,866 of 1946 and amendments provide that division into lots of "non suitable" areas is impeded by virtue of their floodable characteristics. As regards local legal frameworks, each city has approached this issue autonomously, drawing up ordinances and in some cases, Ordering Plans (Planes de Ordenamiento), which provide for this issue. However, these instruments, as well as national laws are not enforced in most cases (Genta *et al.*, 2004).

Many of the damaging adverse meteorological phenomena and extreme hydrological events are neither registered nor evaluated at economic level, and yet the society and responsible authorities have not given the necessary attention to this issue. However, floods are the events with the most important social impact and they are a common problem for the whole basin. Some studies were carried out for the southern part (in the Argentinean sector), but the criteria cannot be applied for the entire basin (Marengo *et al.*, 2004).

7.6. Population movements in the La Plata Basin

The relevance of migration flows between rural and urban settlements –and mainly the migration towards the big cities– has substantially changed. In the eighties, the riparian countries have been experimented a decrease in the migration rate from rural areas to urban ones; moreover, it was over passed by the migration among urban areas. Such evidences have consolidated along the nineties and the last available censual information (dated in the beginnings of 2000s) allowed updating indirect estimations of net rural-urban migration (Table 7.6).

Table 7.6. La Plata River Basin. Net rural-urban migration by country (1980-2000)

Countries	Net Migration (persons)		Net Migration Annual Average Rate (%)	
	1980-1990	1990-2000	1980-1990	1990-2000
Bolivia	565,718	341,525	25.3	9.7
Brazil	9,167,928	9,483,867	11.5	8.8
Paraguay	280,103	---	24.9	---
Uruguay	83,300	---	9.6	----

Note: There are no data for Argentina.
Source: Vignoli, 2004.

According to the values shown in Table 7.6, several conclusions about migration flows could be made (Vignoli, 2004):

- the main urban growth is explained mainly due to the natural (internal) population growth;
- rural-urban migration, as well as the rest of migrations, has an intensity which varies according to age. The youngest are the most inclined to migrate;
- migration to the cities remains as a key force for the continuity of the urbanisation process, because the vegetative growth is still higher in the rural zones;
- migration from the rural to the urban areas remains having a significant impact on the first ones, both on its moderate growth –and the depopulation in numerous zones– and on the aging of population –due to the selectivity of migration, with a pre-eminence of young people–;
- as urban natural population growth decreases to levels close to zero, migration from rural zones might be recover its weight in the urban population expansion; however, the rural-urban migration would not be the most important migration flow again.

7.7. Cities impact on ecology

The results of the environmental reports for Buenos Aires, Montevideo and São Paulo cities carried out within the "Global Environment Outlook" Program (GEO) of the United Nations Environment Program, have been published in the beginnings of 2000s. Following is a summary of these reports' main considerations regarding the impacts on significant natural ecosystems in these three cities.

Buenos Aires City has a highly urbanised land surface of about 200 km^2. Its most significant natural elements are the La Plata River, the gallery forest relicts and the original ravines that were left far from the shore owing to the successive advances towards the riverbanks (IMAE-PNUMA, 2003).

The original ecosystems did not provide the landscape with high visual impact scenery (forests for example) that could last as a natural element to be valued. Instead, the natural place of Buenos Aires was furrowed by little streams, swamps and pastureland that were not valued and disappeared due to pollution and urbanisation processes that gave way to the different neighbourhoods (even below the flood elevation). Nature's transformation processes covered all that was available and the original vegetal communities disappeared. Part of the ravine system is only kept in the borders, where the city met the river. The loss of the horizon occurred by the successive strata that started occupying the riverside. The streams were channelled and the final result was a highly built city that turns its back to the river, despite being its resource of the greatest landscape potential (IMAE-PNUMA 2003).

Montevideo City is developed on a slightly sloped plain (a typical feature of the Uruguayan landscape) in front of the bay that bears its name. Among its natural significant features, the *Cerro de Montevideo* (Montevideo Hill), a flat elevation of 150 m, and the La Plata River with its beaches are the most relevant ones. As a matter of fact, Montevideo Department –to which the city belongs– has some 70 km of sandy beaches that form arches of 13 km in length, interrupted by rocky ends or projections. The zone of Montevideo Metropolitan Area has a 30 km-long shore, besides the Montevideo Bay, where the port is located (PNUMA-IMM, 2004).

Sandy beaches are extremely important since they protect the lands and the existing infrastructure works against the direct action of the river waves and tides. Also, they constitute the foundation of a relevant tourist and recreational infrastructure. However, beyond the effort of conservating this unique beach area, specific deterioration phenomena are observed that spring from natural causes (beaches destroyed by storms with huge waves) and anthropic causes linked to sand extraction or infrastructure works constructions that affect the balance of sediments between the river and the shore (PNUMA-IMM, 2004).

Even though there are some areas that should be protected for their testimonial ecological value, the expansion of the urbanised area inwards produced deep modifications to vegetation. There are still native forest areas, though various species have been settled, like the eucalyptus, that modify the landscape. On the other hand, the fauna shifted from its original habitat and decreased in number and diversity (PNUMA-IMM, 2004).

São Paulo City sits on a little set of hills, fluvial terraces and floodplains that belong to the Southeast portion of the Brazilian Plateau. The city and its metropolitan area are furrowed by different rivers, of which the most important one is the Tietê; in fact, most of the municipality is located in the upper basin of this river. The original ecosystem on which São Paulo expanded is the so-called *Mata Atlântica* (Atlantic Forest), which is still concentrated in the southern and northern ends of the city, contrasting with the magnitude of the urban spot (SVMA-PNUMA, 2004).

The territorial dynamics implied the urban expansion along this original environment, even with irregular land subdivisions, *favelas* (slums), occupation of spring protection areas[36] and advances over the vegetation. The advance of the city over spring areas takes place through irregular subdivisions and informal settlements, since because their occupation is law-forbidden, land cost is reduced and it becomes attractive for low-income inhabitants. Such population, without access to basic infrastructure, dumps waste into the springs, jeopardizing water quality. Another consequence of this process is the increase in the soil erosion rate (SVMA-PNUMA, 2004).

[36] Springs are areas where reservoirs, streams and heads of watercourses are located. In the case of São Paulo, they are located in the Northern area of the Municipality (Cantareira system) and in the Southern sector (Guarapiranga and Billings reservoirs) (SVMA-PNUMA, 2004).

Box 7.4. Ecosystem Protection in the banks of the La Plata River

The urban growth model of the two metropolises situated on both riversides of the La Plata River (Buenos Aires and Montevideo) changed the natural conditions completely. Nevertheless, there are still some regions that succeeded in keeping the original features of the ecosystems.

Figure 7.10. Aereal view of Costanera Sur

Source: http://www.porlareserva.org.ar/FotosAereas.htm

In Buenos Aires, the lack of public intervention and real state investment resulted in the formation of a gallery forest along the river. Even though this forest rests on an artificial physical support (the result of landfills on the river shore), it managed to reproduce with high energy an ecosystem that could be considered original, which on a larger scale is continuous from the Paraná Delta. This ecologic system, composed of swamps, rushes and alder forests, became the livelihood source of a great variety of birds and animals, within an area of 340 hectares. The City Government declared this area as *Parque Natural Reserva Ecológica Costanera Sur* (Southern Riverside Ecological Reserve Natural Park). It is only five minutes from downtown Buenos Aires and its key ecological function is to serve as an entrance door for flora and fauna species that are transported along both the Paraná and the La Plata rivers (PNUMA-PNUMA, 2003).

Montevideo, on the Uruguayan bank, managed to establish a different relationship with the river, conserving the beach zone. Inwards, however, pressure on nature is similar to that in Buenos Aires and urbanisation advanced towards areas considered today of high environmental interest, among which the wetlands of the Santa Lucía River (direct affluent of the La Plata River) are found. In other cases, the beaches and wetlands linked to the watercourses flowing into the La Plata River are threatened by extractive activities, as it happens in the *Bañados de Carrasco* (Carrasco Swamps). In recent years, Montevideo Municipal Intendancy has coordinated actions to achieve protection of these valuable and fragile ecosystems. In the case of the Santa Lucía wetlands, the creation of a Protected Natural Park of some 1,000 hectares was promoted; the singularity of this Park is the existence of a Permanent Advisory Commission intended to work on its conservation and management, following a participatory methodology. In the case of the *Bañados de Carrasco*, actions have been implemented to monitor and regulate turf extraction activities. However, there are no further advances in the management of the area, which is not the case in Santa Lucía (PNUMA-IMM, 2004).

Regarding the advance over the native vegetation, a reduction in the covered surface has been recorded throughout time. The original forest ceded space to other uses and land occupation, beyond urbanisation itself: agriculture, mining activities and reservoirs. At the same time, wildlife also diminished, due to both vegetal cover removal and human action, such as hunting activities (SVMA-PNUMA, 2004).

The areas where the original forest is still kept have different levels of environmental protection: Capivarí-Monos Environmental Protection Area in the South and *Parque Estadual da Serra da Cantareira* (State-owned Park of Serra da Cantareira). There are fragments of secondary native vegetation as well, like remnants of forests and natural fields (SVMA-PNUMA, 2004).

7.8. Urban development and water management

7.8.1. Water demand management

In Argentina, the privatisation of drinking water supply began in the 1990s. At the beginnings of 2000s, the attention of water demand shows multiple situations. So much so that there are 1,548 enterprises or organisms which are in charge of drinking water and/or sanitation services in all the country, both in urban and rural areas. The 70% of those enterprises are private companies and the remaining 30% are state's institutions. It is worth to be mentioned that the private concessionaries –which represent the slightest proportion among the service suppliers– provide the services to over half of the urban population in the country. In all the cases of service's concessions, the State exert the regulation and control functions, through specific institutions which are the Regulation Agencies (Calcagno, 2001).

In the case of Buenos Aires Metropolitan Area (the major urban concentration of the country), *Aguas Argentinas S.A.* is the private company which replaced OSN in the service provision. In the provincial jurisdictions, there are provincial institutions which depend on the provincial government, with different autarchic and autonomous levels (provincial directorates, state-owner Societies, and state-capital corporations) and private-capital corporations' concessionaires of the services. Among the municipal jurisdictions stands out: municipal institutions which depend on the Municipalities with different autonomy levels, but mostly centralised (municipal directorates, state-owned societies), and private concessionary operators such as corporations, cooperatives and neighbours' organisations; the two latter have no profit aims and are integrated by the users (Calcagno, 2001).

The private concession system of service provision was also adopted by Bolivia. In this case drinking water supply is provided by the EPSAs, an acronym for "empresas prestatarias de servicios de agua potable y saneamiento", that is, drinking water and sanitation service provider companies. According to the Law 2,066 of 2000, the concession of the services is given by the *Superintendencia de Servicios Básicos* (Superintendance of Basic Services) which is part of the *Sistema de Regulación Sectorial*, SIRESE (Sectorial Regulation System). The Superintendencia de Servicios Básicos is also in charge of controlling the services, applying the corresponding measures in case of non-fulfilment, and approving the quality goals in the expansion and development of the EPSAs (Congreso Nacional de la República de Bolivia, 2000). In turn, the EPSAs can be part of the *Asociación Nacional de Empresas de Servicio de Agua Potable*, ANESAPA (National Association of Drinking Water Service Companies), which is a not-for-profit civil association created in the 1980s with the goal of contributing to the entrepreneurial strengthening of EPSAs in order to improve the efficiency in service provision (ANESAPA, 2002).

Except the EPSAs which operate in Santa Cruz and La Paz cities, the remaining ones have a weak management capacity. This situation is mainly observed in middle and small cities, where the recent improved systems show an evident deterioration caused by a lack of operation and maintenance. An official evaluation of the privatisation process concludes that it was done rapidly, without completing the regulatory framework and limiting the participation of other interested operators (Viceministerio de Servicios Básicos de Bolivia, 2001).

In Brazil, the Federal Constitution states that the municipalities are responsible for the services of local interest, including drinking water supply. The provision of the metropolitan regions and others with integrated services, legally constituted, must be carried out by the states together with the related municipalities, taking into account the common interest. Both the drinking water and the sanitation supplies are still under the responsibility of agents related to the public sector. The 27 state companies[37] provide the services to the 75% of the urban households in the country; in fact, they have exerted the role of the State –public power– in policy's definition and planning of public actions related to drinking water and sanitation services (Praciano Minervino, 2002). There are also regional and local suppliers (Secretária Nacional de Saneamento Ambiental, 2003).

In Paraguay, the drinking water supply is in charge of two institutions: the *Servicio Nacional de Saneamiento Ambiental*, SENASA (National Environmental Sanitation Service) and the *Empresa de Servicios Sanitarios del Paraguay*, ESSAP (Sanitary Service Company of Paraguay), which has replaced the *Corporación de Obras Sanitarias*, CORPOSANA (Sanitation Works Corporation). The SENASA is a technical institution created in 1972 which depends on the *Ministerio de Salud Pública y Bienestar Social*, MSPBS (Ministry of Public Health and Social Welfare). It is the administrative authority of the *Código Sanitario* (Sanitary Code), in charge of drinking water supply, solid residues and excreta disposal, food control, hygienic and secure working conditions and sanitation services. As regards drinking water supply, the SENASA promotes the creation of *Comités de Saneamiento* (Sanitation Boards) in the urban areas with 10,000 inhabitants or less, as well as in scattered rural settlements (Ministerio de Salud Pública y Bienestar Social del Paraguay, 1998; Gamarra Lovera, 2002). The Sanitation Boards are experiences of decentralisation and community participation, which are integrated by neighbours and service's users, besides the municipalities and the SENASA itself. The Boards administrate the drinking water and excreta disposal systems and guard for the correct operation of wells and latrines (Gamarra Lovera, 1998).

ESSAP was created in April 2002, with the initial aim of privatizing water services provided by the state institution, CORPOSANA. Among its goals, the ESSAP is in charge of the drinking water services supply –in all the stages of the process, from water withdrawal to commercialisation–, the disposal of treatment's waste and the provision of sewerage system services, including its recollection and treatment (Gamarra Lovera, 2002). However, the privatisation process was suspended and the ESSAP still belongs to public administration, under the *Ministerio de Obras Públicas y Comunicaciones,* MOPC (Ministry of Public Works and Communications). The ESSAP has turned to well drilling to fulfil drinking water demand in some neighbourhoods of Asunción, as well as in Asunción Metropolitan Area and other cities of the country (Ministerio de Obras Públicas y Comunicaciones del Paraguay, 2004).

[37] Nine of these 27 agencies serve the Brazilian states of the La Plata Basin: *Companhia de Saneamento de Brasilia*, CAESB (Sanitation Company of Brasilia), *Compañía Catarinense de Águas e Saneamento,* CASAN (Water and Sanitation Company of Santa Catarina), *Companhia de Saneamento de Minas Gerais,* COPASA (Sanitation Company of Minas Gerais), *Companhia Riograndense de Saneamento,* CORSAN (Sanitation Company of Rio Grande do Sul), *Companhia de Saneamento Básico do Estado de São Paulo,* SABESP (Basic Sanitation Company of São Paulo State), *Saneamento de Goiás,* SANEAGO (Sanitation of Goiás), *Companha de Saneamento do Paraná*, SANEPAR (Sanitation Company of Paraná), *Companhia de Saneamento do Estado do Mato Grosso do Sul,* SANESUL (Sanitation Company of Mato Grosso do Sul State) and *Companhia de Saneamento do Estado do Mato Grosso,* SANEMAT (Sanitation Company of Mato Grosso State).

Finally, the *Cámara Paraguaya del Agua*, CAPA (Paraguayan Water Chamber) joins the private drinking water providers which are in charge of supplying those population sectors where the official coverage is not present. The whole private activity is regulated by the *Ente Regulador de Servicios Sanitarios del Paraguay*, ERSSAN (Sanitary Service Regulatory Agency of Paraguay), an autarchic entity which depends on the Executive Power. Its main objectives are the regulation of the service, the protection of the community's interest, and the control of the correct application of the in force dispositions on the issue (Gamarra Lovera, 2002).

In Uruguay the drinking water supply services have always been legally qualified as public services. Consequently the provision of public services as one of the main State's responsibilities has been established. This kind of regime does not allow private activities, since the provision is one of the typical duties of the State's entities, which will act exclusively except in case of authorisations to private persons through concessions (Gobierno de la República Oriental del Uruguay, 2001).

The provision of drinking water is in charge of OSE, which supplies the country's population –both in urban and rural zones– with the exception of the sewerage services in Montevideo, where it is made by the Municipal Intendancy. At the beginning of 2000s, OSE supplies drinking water services in Montevideo and 324 regions in the inner country. In 1994, OSE has established a departmental regionalisation to provide the services, with the goal of achieving a major efficiency by means of a gradual decentralisation in the operations. Some technical, administrative, commercial and support activities are still centralised but the objective is that some of them would be total or partially transferred to each region (Gobierno de la República Oriental del Uruguay, 2001).

Private operators are also present, to whom OSE has granted the service. They are *Aguas Corrientes del Pinar* (in El Pinar City), *Aguas de la Costa* (in the area located at the East of Maldonado stream) and *Uragua S. A.* (West of Maldonado stream, Maldonado Department). These last two concessionaires were operating under the regulation and control of OSE (Gobierno de la República Oriental del Uruguay, 2001). In October 2004, a plebiscite convened in parallel to the Presidential election, promoted a constitutional amendment, keeping the provision of water supply within the public sector.

7.8.2. Decision making mechanisms

In Argentina, the public structure of drinking water supply and sewerage services is the result of the transference of services management from the National State to Provincial States. Until 1980 this activity was carried out by OSN with a central structure and regional management. As from that date OSN provided water and sewerage services in Buenos Aires and 13 municipalities of Buenos Aires Metropolitan Area, while the remaining network was transferred to the provinces. This process has found different scenarios in the provinces, whose governments had to integrate their own management with those applied by OSN's regional offices. The situation has caused the typical difficulties of the coexistence of two different organisational cultures (Calcagno, 2001).

The privatisation of services began in the province of Corrientes and in Buenos Aires Metropolitan Area and was then extended to most of the provinces in the country. The regulation agencies were created at the same time, so the number of stakeholders widely grew. The regulation and control activities are carried out by the granting states (national, provincial or municipal ones) and the regulation is exerted through two kind of instruments: the Regulatory Frameworks and Regulatory Dispositions specified in the Concession Contracts, when the former ones does not exist. As a consequence of this process, the management of drinking water and sanitation sector has remained decentralised in regional, provincial and municipal jurisdictions; therefore, the management presents a wide range of organisational forms which reflect the high organisational complexity of the water sector (Calcagno, 2001).

Once that OSN action scope was limited, the water management activities at national level was primarily developed by a federal organism, the *Consejo Federal de Agua Potable y Saneamiento*, COFAPyS (Federal Council of Drinking Water and Sanitation), constituted by a Board of Directors and an executive body conducted by a President. Later, these activities were developed by the *Ente Nacional de Obras Hídricas de Saneamiento,* ENOHSA (National Agency of Water Works for Sanitation), according to the Law 25,583/95. This is a decentralised institution under the jurisdiction of the *Secretaría de Obras Públicas de la Nación* (National Secretariat of Public Works). Diverse investment programmes on optimisation and expansion of the services were started up through ENOHSA, with the international credit support of the Interamerican Development Bank (IDB) and the World Bank (Calcagno, 2001).

Law 25,583 also foresees the creation of the *Consejo Federal de Saneamiento*, COFESA (Federal Council of Sanitation), integrated by the provincial jurisdictions, as a field of information and experiences exchange among sectorial programmes (Calcagno, 2001). According to Law, COFESA´s objectives are the consideration, coordination and agreement of programmes on drinking water and sewerage works development which will be coordinated through ENOHSA, as well as the promotion and coordination of programmes addressed to the productive and administrative optimisation, rationalisation and reconstruction in the drinking water and excreta disposal supply (Congreso de la Nación Argentina, 1995)

Bolivia has followed a similar scheme in relation to the administrative decentralisation which, in this case, began in the 1990´s decade. One of the most important aspects of this process was the definition of the “municipality” as a geographic and administrative entity of management and development. The municipal governments got new administrative and planning attributions; among them, the control and/or provision of drinking water services and accomplishment of national and municipal regulations related to water use can be mentioned (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

Law 2,066 establishes that the regulation of the drinking water service is a competence of the national state, through the *Ministerio de Vivienda y Servicios Básicos,* MVSB (Ministry of Housing and Basic Services) and specifically, through the Superintendencia de Servicios Básicos. The municipal governments are responsible for assuring drinking water supply, either directly –through municipal companies–, by means of agreements with social entities or through EPSAs. On the other side, the municipal governments also contribute with the Superintendencia de Servicios Básicos to the follow-up and control of the EPSAs; the latter institution has the competence of granting the service (Congreso Nacional de la República de Bolivia, 2000).

In Brazil, the *Secretaria Nacional de Saneamento Ambiental* (National Secretariat of Environmental Sanitation) depending on the *Ministério das Cidades* (Ministry of the Cities), is the national institution in charge of assuring the fundamental human rights of access to drinking water and to live in a healthy environment, both in urban and rural areas, by means of the extension of water supply, sanitation, solid wastes recollection and treatment, urban drainage system and the control of contagious diseases vectors (Secretária Nacional de Saneamento Ambiental, 2005). This Secretary is also the coordination body in the preparation and execution of environmental sanitation national policy, and the manager of the resources within the Ministério das Cidades.

Drinking water services in Brazil (including urban areas) are currently provided by public entities, which face difficulties to operate in a regime of efficiency. Public regulation and control are instruments for the efficiency of these operators, specially the mixed economy societies. The services' regulation splits the public functions –typically governmental, such as policies formulation– from those related with the services' rendering –typical of the companies–. On the other side, regulation binds companies to achieve rules and milestones in the services' rendering (Praciano Minervino, 2002).

Many public and private institutions linked to water supply and sanitation exists in Paraguay. The national government establishes the policy to be applied in the sector by means of laws, regulations and norms. The government also signs international agreements once the Executive Power has approved them and the Parliament has ratified them (Ministerio de Salud Pública y Bienestar Social, 1998). The ESSAPs, the sanitation boards and the small private companies or water sellers are the provider entities of drinking water and sewerage services, while SENASA has as priority drinking water supply more than the water-flushing sanitation service. In the practice, this multiplicity of actors attains a good institutional articulation (Gamarra Lovera, 2002).

All projects in rural areas tend to improve drinking water and sewerage services coverages and thus improve health standards and promote population's root. The achievement of this goal entails the optimisation of the operative capacity of the population, the predisposition to the projects' auto financing, the development of the entrepreneurial management in the community and the communitarian participation (Gamarra Lovera, 2002).

The private participation in drinking water services supply in some urban areas –and mainly suburban ones– is carried out by water sellers. The activity of these small providers does not have any regulation and control norms, neither any kind of guarantee of the service or product quality. The coverage of urban zones, performed by the ESSAP, is still weak. The creation of ERSSAN in 2001 has tended to promote the private participation in drinking water supply, as a way to increase the service's coverage (Gamarra Lovera, 2002).

Lastly, the water and sanitation sector in Uruguay has not a unified planning as such. Every involved institution elaborates its own plans and particular policies. In the case of OSE, the general policy definitions approved by the end of 90´s include (Gobierno de la República Oriental del Uruguay, 2001):

- its preservation as a public company of national scope with a clear territorial decentralisation in the provision and administration of the resources;
- the application of public works and services concession regimes, as a way to accelerate the investment in projects and their execution;

- the practice of a management with entrepreneurial orientation; and
- the promotion of the access to drinking water and sanitation services for population of all social levels and geographical localisation.

At the beginning of 2000s, the legislation in force enables OSE –as the owner of the service– to grant the services with the respective authorisation of the Executive Power. Thus, the drinking water supply service is granted in the East and West fringes of the Maldonado Stream, where *Aguas de la Costa S.A.* and *Uragua S.A.* are the providers, respectively. On the other hand, and according to the Population Centres Act, the first developers have the right to create services within the areas to be allotted; the developers have two unavoidable conditions: 1) the service must not exist in the lots; 2) OSE must approve the projects and control the works; then, these works will be given to OSE freely (Gobierno de la República Oriental del Uruguay, 2001).

7.8.2.1. Public participation

In Argentina, the 1994 National Constitution has included an article to contemplate the participation of consumers` association in the regulating bodies, but this article has not been regulated. The community participation in the service provision is confined to cooperatives and neighbours' associations. The community participation has an incipient development when the services supply is done by the State or private companies. On the other hand, there is a strong tendency to actively participate in the decisions of regulating bodies, such as the *Ente Tripartito de Obras y Servicios Sanitarios,* ETOSS (Tripartite Agency of Sanitary Works and Services), integrated by the National State and the governments of the Buenos Aires Province and Buenos Aires City. The ETOSS has encouraged the community participation by means of a users' commission financed by the agency. Some regulatory frameworks have incorporated the users' participation through advisory boards formed by consumers' associations (Calcagno, 2001).

The public hearings or popular consultations convened by the regulating agencies are others methods for users' participation; these methods are applied by ETOSS at the moment of planning and execution of infrastructure works which will influence the services' invoicing. Another methods of users' consultation are also foresaw, such as opposition registers or opinions polls; both of them are applied when the expansion of services is projected (Calcagno, 2001).

In Bolivia, the *Consejo Interjurisdiccional del Agua*, CONIAG (Interjurisdictional Council of Water) created in 2002, is a field of open dialogue and discussion between the Government and the civil society –by means of its organisations– to build a legal, institutional and technical framework related to water issues. The CONIAG is integrated by the *Ministerio de Desarrollo Sostenible y Planificación*, MDSP (Ministry of Sustainable Development and Planning), the *Ministerio de Agricultura, Ganadería y Desarrollo Rural*, MAG (Ministry of Agriculture, Livestock and Rural Development), the *Ministerio de Desarrollo Económico,* MDE (Ministry of Economic Development) and the MVSB, accredited representatives of the municipalities and five representatives of the civil society (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

In Brazil, the PROSANEAR Programme, of the federal government, promotes community participation through its organisations in the implementation of integral sanitation projects in intermediate and small cities. These programmes are mainly oriented to low-income population and they are implemented at a state level.

On the other hand, state-owned sanitation companies also promote community participation through different mechanisms. SABESP, for example, has put into motion a Community Participation Program since 1995. The company democratised access of all its clients and promoted the participation of the São Paulo society in the environmental sanitation management, through associations with their different representatives (SABESP, 2005 a).

In Paraguay the departmental Sanitation Boards are good examples of decentralised and participative management experiences, inserted in rural or small urban contexts. In urban areas, the community management is minimal. The self-management projects are not significant and the relation operator-consumer is merely commercial, although the community participation is tending to be strengthening through the municipal authorities (Ministerio de Salud Pública y Bienestar Social el Paraguay, 1998).

The institutions in charge to supply the drinking water and sanitation services in Uruguay have no tradition in fostering the community participation in the management decisions. Decisions have been generally executed by politic and technical actors, who have opted by general action's policies according to the human, technological and economic existing resources. At the same time, there is a tradition in attending the community's demands and solving their requests. This has given way to the concretion of many agreements to extend the service networks; in such agreements, the organised community –by means of neighbours' commissions, directive boards of housing cooperatives, among others– contributes with labour force.

There are no base organisations which have water and sanitation issues as a main objective. The supply problem is generally one more item, among others. The organised community applies directly to the institutions or searches for strategic allies to strengthen its applications, being generally those allies the neighbours or community centres and the Municipality itself (Gobierno de la República Oriental del Uruguay, 2001).

7.8.3. Pricing policies

In Argentina, the regulating agencies are in charge of both approval of tariff charts and control the fulfilment of those charts by the service's concessionaries. Most of the tariff's regimes in the country have incorporated a crossed subsidy between the high income population and the low income one, through the application of coefficients influencing the tariffs. Drinking water and sanitation supply services have not explicit social tariffs (Calcagno, 2001).

In Bolivia, the Law 2,066 establishes the principles to set prices and tariffs to be applied by the EPSAs, as drinking water supply concessionaires. According to that law, the Superintendencia de Servicios Básicos is in charge to approve and verify the maximum tariffs applied to drinking water provision and sanitation services. The tariff regime of the EPSAs must be oriented by principles of economic efficiency, neutrality, solidarity, redistribution, financial soundness, simplicity and transparency. This means that tariffs should not transfer the costs of inefficient management to the users, which will be oriented to recover expenses and operational costs of EPSAs.

In Brazil, the tariff for the water supply service is established at a state level. Each state-owned company applies a tariff policy that in general springs from directives of state governments. Generally, the applied tariff charts seek to reconcile the economic feasibility of companies and the social aspects of sanitation services (SABESP, 2005 b). The objective is guaranteeing water supply to the whole population, regardless of their economic situation, and at the same time discouraging abusive consumption (CAESB, 2005).

In Paraguay the Law 1,614/2000 establishes that ESSAP is in charge to regulate the tariffs' regime. The tariffs' charts of the services provide by the concessionaries will be applied according to the concession or permission contract, with a previous agreement of the ERSSAN. The ERSSAN also approves the tariff's charts of the private providers –the water sellers–. Eventual modifications to these tariff's charts have also been foreseen in the concession contracts and must be agreed with ERSSAN; those modifications should not be applied to cover eventual financial losses of the concessionaries in any case. The ERSSAN designs and applies methodologies, procedures and calculation formula of the tariffs, which all should be applied by the service provided in all the cases (Congreso de la Nación Paraguaya, 2000).

The basic concepts and tariff' structure of OSE in Uruguay were established in June, 1969. In that date OSE, together with the Panamerican Health Organization (PAHO), carried out a study on tariffs, in order to cover operation, functioning and investment costs according to the annual budget; the study also indicated the updating methodology to be applied, including each period budget needs. At the beginnings of 2000s, tariffs adjustments are applied half-yearly, according to the inflation's behaviour. OSE tariffs as from January 2000 considered five consumers categories: residential, commercial, industrial, official and state companies, with equal values for the whole country, except the beach zone of Maldonado, where a higher tariff was applied (Gobierno de la República Oriental del Uruguay, 2001). On the other side, the concessionaries in charge to the service of drinking water have collected their tariffs according to the applied by OSE.

7.9. Other problems in urban and rural settlements

7.9.1. Other problems in urban areas

According to GEO-cities reports, similar problems have been observed in three major cities of the basin (Buenos Aires, Montevideo, São Paulo) and are briefly described as follows:

- Air Pollution

Buenos Aires and Montevideo have geographical conditions (flat topography, habitual wind directions) that facilitate the dispersion of polluting gas concentrations. Also, in the case of Montevideo the volume of emissions is relatively low (PNUMA-IMM, 2004). In Buenos Aires, on the other hand, high levels of noxious gases in the atmosphere are only observed in the downtown area, mainly due to vehicle emissions. Carbon dioxide and nitrogen oxide have been detected. Besides, there is noise pollution in some street intersections in the downtown area (IMAE-PNUMA, 2003).

In São Paulo, measurements taken by the municipal government between 2000 and 2003 indicate that air quality is from good to regular. In this context, specific areas with bad air quality due to high ozone concentrations are observed. On the other hand, noise pollution has expanded all over the urban territory, reaching high levels according to the guiding values used. The major noise sources are the automobile and air transport[38] (SVMA-PNUMA, 2004).

- Soil Pollution

Montevideo has some problems of soil pollution by heavy metals (especially lead) located mainly in informal settlements, around industrial nuclei with inadequate waste elimination processes or in areas where activities that generate polluting substances are carried out, like wire burning, inadequate management of batteries and other materials (PNUMA-IMM, 2004).

In Buenos Aires city, soil pollution risk is mainly associated with the existence of open-air waste dumps. The way in which waste is disposed –without any type of safety measures– may cause pollution not only to soils but also to water table, surface watercourses and the air. These dumps are in general associated to slums, which diminish the inhabitants' life quality even more (IMAE-PNUMA, 2003).

In São Paulo, the presence of polluted soils is associated with areas mainly degraded by chemical processes. According to data from the *Companhia de Tecnología de Saneamento Ambiental,* CETESB (Environmental Sanitation Technology Company), during 2003 there were some 700 polluted areas in the entire São Paulo State, of which 43% was located in São Paulo municipality. CETESB data from 2004 indicate that about 80% of the 410 polluted areas of the municipality were polluted by fuel at supply points; all these areas are located in the centremost area of the municipality. Another relevant piece of data is the trend towards an increase in the number of areas with pollution problems (SVMA-PNUMA, 2004).

- Solid waste generation and disposal

Over the last years, there has been an increase in the generation of urban solid waste in the three major cities considered herein. In general, this increase is linked to consumption habits, especially of middle-high and high classes of the society. In all the cities, a "spatial division" of solid waste generation is recognised, which coincides with territorial segregation by social classes (PNUMA-IMM, 2004; IMAE- PNUMA, 2003; SVMA- PNUMA, 2004).

In the case of Buenos Aires, apart from the generation increase, a decrease in waste collection took place due to two major factors: on the one hand, a consumption decrease among the poorest classes as a result of the economic crisis and recession, and on the other hand, a rise in informal waste collection. According to data provided by the *Secretaría de Planeamiento Urbano* (Secretariat of Urban Planning) of the Buenos Aires City Government, the "cartoneros" –name given to informal paper and cardboard collectors– recycle almost 8,000 kg/day of paper (IMAE- PNUMA, 2004).

In Montevideo, there are problems due to inadequate practices of the population, like, for example, dumping in the public ways and other inadequate places, putting domestic waste out

[38] The importance of air transport as a noise pollution source relates to the importance that helicopters have acquired as a means of transport in the city. There are 174 heliports in São Paulo Municipality, in addition to the three airports (one international, two domestic) located in the periphery (SVMA-PNUMA, 2004).

of the households ignoring collection timetables. The presence of classifiers' discards and excrements of pet animals in the public ways is also observed (PNUMA-IMM, 2004).

In São Paulo, finally, solid waste-related problems have to do with the final disposal that can be done in authorised areas ("aterramentos") or else in inadequate places (locally known as "bota foras"). In the case of "aterramentos", there are good-quality ones in the city, though there are few areas left to build new ones. In the case of "bota foras", they are located in the city periphery and are destined, in general, for the disposal of construction and demolition waste. In these areas, associated problems are observed, such as soil and water pollution, vegetal suppression and damage to the nearby households. As regards generation, even though companies are the main generators, private individuals are the main responsible for clandestine dumping (SVMA- PNUMA, 2004).

- Recreational and Public Areas

In Montevideo, the beaches of the La Plata River have adequate conditions in general, except after intense precipitation. On the other hand, some problems in terms of water quality for leisure use have been detected, as a result of microbiological pollution in some beaches. This pollution resulted from leakages in the sub aqueous sewer outfall and pollution of surface water sources (nearby streams). Also, toxic algal blooms have appeared on the shores (PNUMA-IMM, 2004).

In São Paulo city, water quality for leisure use is monitored in the Guarapiranga Reservoir, whose waters are used for sail sports. CETESB, which is the organisation in charge of monitoring the reservoir, adopts an Annual Rating as a term of reference that is also applied to maritime beaches. According to data provided by this organisation, between 1993 and 2001, water quality for leisure use was rated as bad in six out of the thirteen monitoring points of the Guarapiranga Reservoir, whereas in the other seven points it was rated as regular (SVMA-PNUMA, 2004).

In other public places (like parks, squares) identified problems usually derive from inadequate use like, for example, practice of sports activities in inadequate places, destruction of signs and other equipment, dumping of solid waste and excrements of pets and other animals, etc. (PNUMA-IMM, 2004). Besides, in Buenos Aires and São Paulo these spaces are scarce and unevenly distributed in the urban framework. The result is not only degradation by overuse, but also difficulties as regards accessibility: in the case of Buenos Aires, there is a significant percentage of the population with no access to these spaces, whether due to distance or cost (IMAE- PNUMA, 2003).

Restrictions to use of recreational public spaces are even higher in the Argentine bank of the La Plata River. On one hand, a high percentage of the riparian area is of private property or under concession; data from 1998 show that only almost 20% of the riverbank of Buenos Aires had free access to the river. On the other hand, water pollution impedes carrying out recreational activities of direct contact. Finally, there is a lack of an institutional and legal framework so as to consider the riverbank in an integrated way, which could bring about potential conflicts as a result of real or apparent overlapping of jurisdictions and powers of the different enforcement authorities (IMAE- PNUMA, 2003). The Programme *Buenos Aires y el Río* (Buenos Aires and the River) implemented by the Buenos Aires City Government, has made progress in the solution of problems linked to the restriction on the use of the riverbank of the La Plata River in Buenos Aires.

7.9.2. Other problems in rural areas

Bolivia and Paraguay are the two countries of the basin with an agricultural profile. Both countries face similar social and environmental problems, highlighting the high poverty rates. The *Estrategia Nacional de Desarrollo Agropecuario y Rural*, ENDAR (National Strategy of Agriculture, Livestock and Rural Development) developed by the *Ministerio de Asuntos Campesinos y Agrarios,* MACA (Ministry of Peasant and Agricultural Affairs) of Bolivia, identifies diverse causes to explain said situation. These causes are: extreme small farmstead, strong dependence on climate factors, soil impoverishment, overgrazing, lack of adequate and sustainable systems and services of applied research, inadequate marketing systems and insufficient basic services. A core concern is the high food vulnerability of rural zones, mainly in the inter-Andean valleys of Northern Potosi, Central Chuquisaca and Northern Tarija. This situation is intensified by the incidence of extreme climate events and the loss of ecosystems' productive capacity (Ministerio de Asuntos Campesinos y Agropecuarios de la República de Bolivia, 2005).

In the rural-urban transition region (the so-called "periurban"), problems derived from city growth pressure upon soils that usually have great agricultural potential have been observed. The periurbans of Buenos Aires, Montevideo and São Paulo are examples of such situations. In general, agricultural and livestock activities linked to cities' supply –as fruit horticulture– are located in this area.

In the periurban of Montevideo, fruit horticulture and flower production have an important share in the national total. In this region, a small part corresponds to significant ecological areas (wetlands, relicts of native forest). On the other hand, a considerable proportion of rural soils are affected by some degree of erosion and degradation due to organic material loss and structure deterioration. The use of agrochemicals, like fertilisers and pesticides**,** creates pollution problems that are still not properly recorded (PNUMA-IMM, 2003).

In São Paulo, agricultural activities concentrate in the South, in the area close to the Billings and Guarapiranga reservoirs. Horticulture is practiced with low levels of mechanisation, which includes a hydraulic performance below the required basic coefficients due to the lack of adoption of a management system for used water. Another identified problem is the use of agrochemicals by 92% of rural production units (SVMA- PNUMA, 2004).

The expansion of the Buenos Aires Metropolitan Area eventually had an impact on a resource that is today highly valued and scarce, since it was done at the expense of a soil with a high agricultural productivity. In fact, 40% of Buenos Ares City surface is developed on this type of soils, those of the highest fertility in the entire region (IMAE- PNUMA, 2003).

Box 7.5. Gran Chaco Americano Diagnosis

The *Programa de Acción Subregional para el Desarrollo Sustentable del Gran Chaco Americano* (Subregional Action Programme for the Sustainable Development of the Gran Chaco Americano) started in September, 2001. It is fostered by the governments of the countries sharing the Gran Chaco (Argentina, Bolivia and Paraguay) and financed by the UNDP. Its general objective is to improve the socioeconomic conditions of the population, preserving, conserving and restoring the ecosystem through common actions for the sustainable use of natural resources, through a participatory process.

Figure 7.11. Boreal Chaco in Paraguay

Source: http://content.answers.com/main/content/wp/

Depopulation, poverty and environmental degradation are common problems in the three countries. The Argentine Chaco, in spite of having a high population density compared with the other two countries, is an area that has permanently expelled population since the beginning of the twentieth century, and it shows the lowest socioeconomic indicators in the country. The Bolivian Chaco is an object of national interest (according to several documents and official plans); it is a hydrocarbon producer and a centre of border trade. Nevertheless it remains poor and uninhabited. The Paraguayan Chaco is the most systematically studied, and it is object of official and non-official actions (similar to the Bolivian Chaco); nevertheless, it is the most uninhabited. Also, it is the place with the most developed community in the entire Chaco Americano, which has achieved the highest quality of life, systematised its experience and permanently reviewed its production and management technologies (Ledesma, 2000 b).

Livestock is the predominant activity in the Bolivian Chaco, although the animal load per hectare is on the verge of overgrazing. Agriculture is practiced at a subsistence level, and the main crop is corn; soybean is positively expanding, due to economic rather than agro ecological reasons. Some European immigrant colonies (Mennonites) develop the cotton culture. In the zones bordering with Argentina there is an intense movement of people travelling with formal and, many times, informal commercial purposes (Ledesma, 2000 a). Livestock and agriculture are the main activities in the Paraguayan Chaco. The Mennonite colonisation repeats here, but with a greater spatial continuity than in the case of the Bolivian Chaco. The major conflict results from the limited existence of surface water resources and the fragility of the soils in an advanced state of erosion. Deterioration of natural resources and subsistence ways leads to overuse resources even more to satisfy basic needs of food, housing and maintenance. Thus, the chain poverty-environmental degradation- poverty replicates.

With this diagnosis, the three countries are working to define action criteria that tend to promote the strategic planning in the use of ecosystems, favour the development of local communities (mainly indigenous and rural), reduce rural poverty as a tool to prevent resource degradation and integrate the communities' development objectives with those intended for resource conservation. In this framework, the project *Gestión Integrada y Desarrollo Sostenible para Reducir la Degradación Social, Económica y Ambiental en el Gran Chaco Americano* (Integrated Management and Sustainable Development to Reduce Social, Economic and Environmental Degradation in the Gran Chaco Americano) was put into motion in 2004 with the objective of reverting the damaging processes that affect the region and improving the population's life conditions through a participatory model of integrated management of ecosystems (UNDP, 2005).

Challenge: Water and Food

Overview: Enhancing food security, particularly of the poor and vulnerable, through the more efficient mobilization and use of water and the more equitable allocation of water for food production is one of the biggest challenges facing the humanity.

8. Water and food in the La Plata Basin

8.1. Surface area and total cultivated area[39]

Argentina has a percentage of 12.8% of arable land, which represents 35,000,000 ha of its national territory. This is the higher percentage, followed by Brazil, Paraguay and Uruguay. Table 8.1 shows the total arable and non arable lands, and their percentages over total surface area. Table 8.2 shows the distribution of the agricultural area in percentages, by country.

Table 8.1. La Plata River Basin. Arable and non-arable lands by country

Countries	Land Area (10^3 ha)	Arable & Permanent Crops		Non-Arable & Non-Permanent*	
		Total (10^3 ha)	% over Land Area	Total (10^3 ha)	% over Land Area
Argentina	273,669	35,000	12.8	238,669	87.2
Bolivia	108,438	3,106	2.9	105,332	97.1
Brazil	845,942	66,580	7.9	779,362	92.1
Paraguay	39,730	3,115	7.8	36,615	92.2
Uruguay	17,502	1,340	7.7	16,162	92.3

* Includes lands with permanent pastures.
Source: FAO, 2004

Table 8.2. La Plata River Basin. Distribution of the agricultural area by country

Countries	Agricultural Area* (10^3 ha)	Arable & permanent crops (%)		Permanent Pasture (%)
		Arable Land (%)	Permanent Crops (%)	
Argentina	177,000	19.0	0.8	80.2
Bolivia	36,937	7.9	0.5	91.6
Brazil	263,580	22.4	2.9	74.7
Paraguay	24,815	12.2	0.4	87.4
Uruguay	14,883	8.7	0.3	91.0

* Includes both agriculture (arable and permanent crops) and livestock activities (permanent pastures).
Source: FAO, 2004.

[39] See Annex I for methodological considerations on the information presented in this chapter.

8.1.1. Irrigated land: current use and future projections

Systematic studies carried out during the first years of 2000s provide information on land devoted to irrigated agriculture. This information is presented in Table 8.3.

Table 8.3. La Plata River Basin. Total irrigated area and as a percentage of cultivated area

Countries	Irrigation area (ha)	% of total cultivated area
Argentina	832,510	2.7
Bolivia	103,037	6.7
Brazil	2,237,227	7.5
Paraguay	67,000	0.3
Uruguay	217,593	16.8

Note: Data for Argentinean provinces, Bolivian departments and Brazilian states included in the La Plata Basin. Data for entire countries in case of Uruguay,
Sources: INDEC, 2002; Ghirardi, 2003; Van Damme, 2002; DIEA, 2000; FAO, 2000 d.

As the Figure shows, the percentage of irrigated land over the total cultivated area is very low in the basin. Only Uruguay has a great participation of irrigation in agriculture; this is a consequence of an intense and sustainable development of irrigation since 1996, through the use of groundwater and the construction of reservoirs devoted to irrigation. The irrigated area has been increasing mainly due to the growing of rice production (FAO, 2000 e).

On the other hand, Paraguay has the lowest percentage of irrigated land in the basin. In fact, irrigation is scarcely developed in Paraguay, only spread in the Eastern region, where mostly superficial waters are used –rivers and streams–. The irregular distribution of rainfall produces lack of water in some areas of this Eastern region; thus, irrigation is needed. On the other hand, weather conditions and the geographical isolation have limited the agricultural development in the Western Region (FAO, 2000 d).

Argentina has also a low participation of irrigation in agriculture. The irrigated area has had a discontinued evolution through time: the amount of hectares under irrigation increased slowly, from 1,065,000 in 1970 to 1,561,000 in 2000 in all the country. The evolution in such period has been very variable considering the different regions; for example, the activity grew up greatly in the humid sector of the La Plata Basin, where supplementary irrigation is especially focused to cereals and grains (FAO, 2000 a).

Although official estimations point out that Argentina has approximately 95 million hectares of soils apt for irrigation, the availability of water limits the development. If both soil conditions and water availability are considered, the potential irrigation area is estimated near 6.1 million hectares, 44% of which are located in the arid regions and the remaining 56% in the humid ones (FAO, 2000 a).

Considering weather conditions, soils aptitude and availability of water resources, the potential irrigation surface in Bolivia, is estimated in 2 million hectares. However, diverse factors –natural, social, economic, institutional- limit the development of irrigation in the country. That is why an evaluation made by the *Programa Nacional de Riego y Drenaje*

(National Programme of Irrigation and Drainage) points out that the area apt for irrigation in 1991 –for rehabilitation or transformation in a mid-term– was estimated in 260,000 ha, 63,000 ha of which need rehabilitation (FAO, 2000 b). In the beginning of 2000s, irrigation has been sustained through different initiatives.

Finally, irrigation started in Brazil in the XX century, in Rio Grande do Sul State (La Plata Basin) and in the semi-arid region (NE of Brazil). The irrigation potential of Brazil is estimated in 29.3 million ha, including only areas where irrigation can be developed and excluding the areas of high ecological value in the northern region. In the savannahs (known as "cerrados") of the centre-western region, the potential for irrigation has expanded substantially in recent years, due to recent progresses in soil management and irrigation techniques applied in the region (FAO, 2000 c). Irrigation is still important in the southern region of the country, especially in those lands devoted to rice crop (IRGA, 2005).

8.1.1.1. Water use for irrigation

The water demand, extraction and use is extremely high in agriculture –and especially in irrigation activities– as compared to other consumptive uses. The proportional participation of agriculture in water demand varies between 50% and 80%, depending upon countries and regions. These percentages decrease when considering the participation of water demand and extraction for irrigation purposes in the total renewable water resources available in each country (see Table 8.3)

Table 8.4. La Plata River Basin. Irrigation water use by country (2000)

	Total renewable water resources (km^3)	**Irrigation water requirements (km^3)**	**Water requirement ratio (%)**	**Water withdrawal for agriculture (km^3)**	**Water withdrawal for agriculture* (%)**
Argentina	814	3.43	16	21.52	2.6
Bolivia	622	0.25	23	1.16	0.2
Brazil	8,233	6.21	17	36.63	0.4
Paraguay	336	0.08	23	0.35	0.1
Uruguay	139	0.66	22	3.03	2.2

Note: * Percentage over total renewable water resources.
Source: FAO, 2005 c

In Argentina, irrigation water requirements lead water extraction and represents 75% of the total use in all the country. Considering some of the provinces located into the La Plata Basin (Corrientes, Chaco, Entre Ríos, Formosa, Misiones and Santa Fe), irrigation is used to cultivate rice, meanwhile in other provinces (as Buenos Aires) complementary irrigation is used for grains and is generally carried out using groundwaters (Mugetti, 2004).

In Bolivia, irrigation represents more than 80% of the agriculture's demand of water, being more important than urban and industrial-urban uses. In 2000 the *Ministerio de Agricultura, Ganadería y Desarrollo Rural*, MAGDR (Ministry of Agriculture, Livestock and Rural Development) made an inventory of the irrigation systems in Oruro, Potosí, Chuquisaca, Tarija and Santa Cruz departments (all of them located in the La Plata Basin), where rainfall is very scarce and agriculture is devoted to basic products. According to this study, water from rivers constitutes the main irrigation source; irrigation from water springs is also very common in La Paz and Potosí departments (Van Damme, 2002).

In the Brazilian states of the La Plata Basin, irrigation requires around 50% of the total water demand. The percentage varies according to each sub-basin: in the Uruguay sub-basin irrigation participation reaches 91%, while in the Paraguay sub-basin reaches 35% and the 33% in the Paraná sub-basin (Dias Coelho, 2004).

Irrigation is the use which consumes the higher water volumes in Paraguay, even when it is not a fully developed activity yet. Generally, the producers supply themselves from surface water, which widely predominate over groundwater (Crespo & Martínez Luraghi, 2000).

Finally, irrigation is the main water use in Uruguay. Water for irrigation represents around 56.4% of water volumes extracted from direct intakes, a 93.2% of the volumes of dammed water and a 53% of water volumes extracted from aquifers (Genta *et al.*, 2004). Rice is the main irrigated crop and represents 91% of dammed water and 71.1% of annual water volume extracted through direct intake. Other agricultural products obtained with irrigation are fruits, vegetables, vines, citruses and sugar cane; these products require the 4.5% of collected water and the 8.9% of water extracted from direct intake (von Cappeln, 2002; Genta *et al*., 2004).

Rice in Uruguay is irrigated with superficial waters and flooding. The necessity of water leads to the construction of collecting works –such as ponds– to ensure the availability of the resource; these works are mainly built by private users (von Cappeln, 2002; Genta *et al*., 2004).

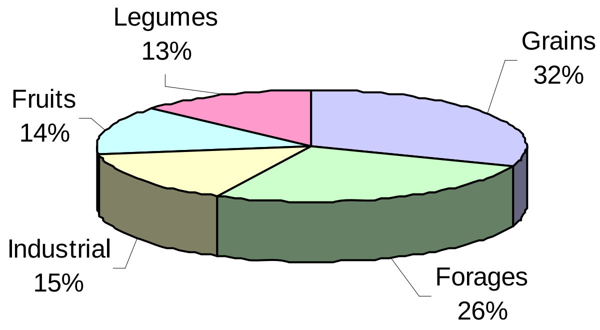
- Major irrigated crops

In Argentina, the main irrigated crops vary across the La Plata Basin. Grains, vegetables and industrial crops predominate in Buenos Aires, Córdoba, Santa Fe and Entre Ríos provinces; rice and fruits predominate in the Northeast (Formosa, Chaco, Misiones and Corrientes provinces), and are also important in Entre Ríos Province, where the geographic and environmental characteristics are similar to those of Corrientes Province (Fiorentino, 2005). The distribution of crops in the Argentinean provinces of the La Plata Basin is shown in Figure 8.1.

Around 173,000 ha of rice were seeded in the 2003/2004 campaign. This area was distributed among six provinces of the La Plata Basin (Corrientes, Entre Ríos, Santa Fe, Formosa, Chaco and Misiones), representing 0.60% of total cereal and oil-crops irrigated area, and 1.04% by considering the area cropped with cereals (Fiorentino, 2005).

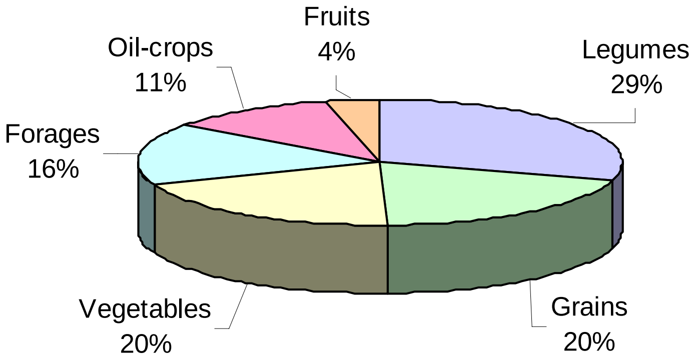
In Bolivia irrigated crops vary in the different geographic areas of the country. Potatoes, coca, quinua and other grains are the main irrigated crops in the Altiplano; maize, fruits, legumes and potatoes predominate in the valleys, while a commercial agriculture –based on sugar cane, cotton, soybean, coffee, etc– is being developed in the Llanos with a good future perspective, especially for external markets (FAO, 2000 b). Figure 8.2 shows the participation of the main irrigated crops in the 1998-1999 campaign, considering the Bolivian departments of the La Plata Basin.

Figure 8.1. Argentina. Major irrigated crops in provinces of the La Plata Basin (2002)



Source: Based on Fiorentino, 2005 and INDEC, 2002

Figure 8.2. Bolivia. Main irrigated crops in the departments of the La Plata Basin (2000)



Source: Based on Van Damme, 2002.

National Bolivian production of legumes, tubers, vegetables and forage mostly depend on irrigation. The 60% of the potato, which is a fundamental tuber in the Bolivian diet, is produced using irrigation (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

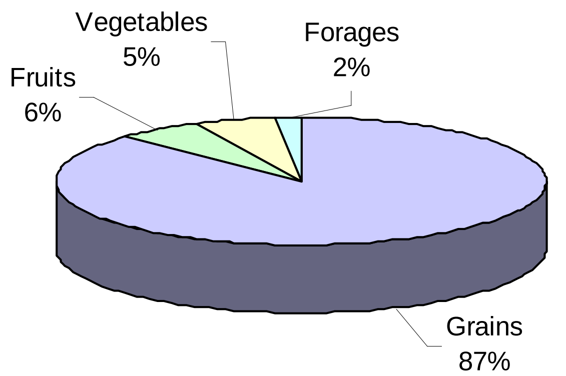
In Brazil, the irrigated agriculture represents 5% of the whole cultivated area. In spite of this lower percentage, irrigation consumes 61% of the water resources (Werneck Lima *et al*, 2000). According to FAO, the range of crops grown under irrigation in Brazil is diverse. In addition to basic commodities (like wheat, maize, rice, beans, soybeans and cotton), high-value crops –like vegetables– are cultivated near the most important urban markets of the industrial Southeast. The same markets are supplied off-season with fruits, onions, melons and other vegetables from the Northeast (FAO, 2000 c).

Statistical information in Brazil does not differentiate between irrigated and non-irrigated cropping areas, except in the case of rice, which is always obtained by means of irrigation. In 2001 rice took up 87% of the irrigated surface in the nine states of the basin. Such percentage shows the importance of rice among the crops obtained under irrigation, which is particularly relevant in Rio Grande do Sul State. In this state, the participation of rice share reached 97% of the lands under irrigation (Ghirardi, 2003; CONAB, 2005 b).

According to FAO, rice is also the main irrigated crop in Paraguay. This crop occupies around 20,000 ha out of 67,000 dedicated to irrigation, which means a percentage of 29.8%. The remaining area is cropped with strawberry, tomato, legumes and some other fruits (FAO, 2000 d). In 2003, the area harvested with rice was around 28,000 ha (CEPAL, 2004 a).

In Uruguay, the irrigated area has had a sustainable development since 1970, and rice is the main crop. Official estimations indicate that rice participation over irrigated land increases in around 10,000 ha/year. The last years of 1990 decade also showed an increase of the irrigated area cropped with fruits, citric, non traditional vegetables and summer crops –such as maize and sorghum–. On the other hand, irrigated area devoted to sugar cane has decreased (FAO, 2000 e). Figure 8.3 shows the share of crops in total irrigated land in Uruguay.

Figura 8.3. Uruguay. Main irrigated crops (2002)



Note: Data for entire country.
Source: Based on DIEA, 2004

- Yields of irrigated agriculture[40]

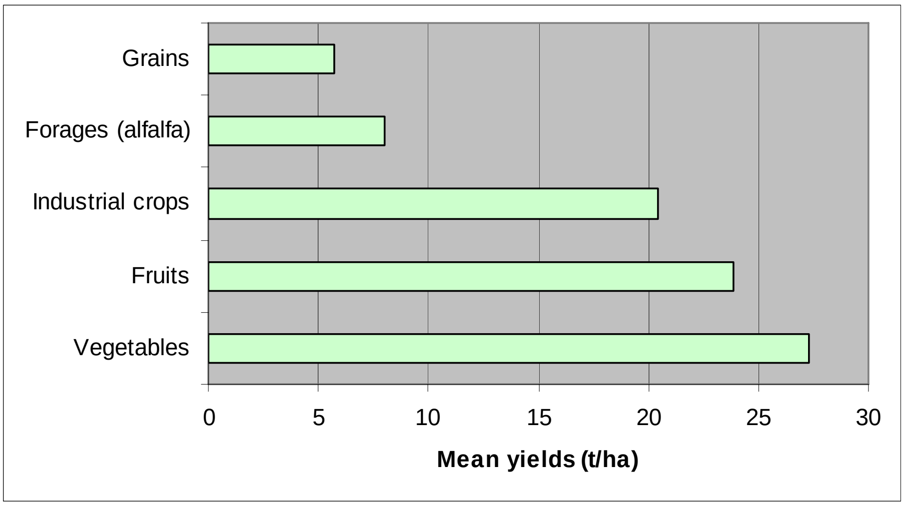
Fruits and vegetables had the higher yields among the irrigated crops for the 2001-2002 campaign in Argentina. In this campaign, fruits have had a mean yield of 23.9 t/ha and vegetables a mean of 27.3 t/ha (see Figure 8.4). The higher yield increases between 1988 and 2003 were registered in alfalfa among forage crops, tomato and potato among the horticultural crops, plums among fruits, sugar cane and rice (Fiorentino, 2005).

The variations in the national and international grain markets influence the decisions on private investment in different crops. For example, since 1999, the changes in international prices of rice reformulated the scenario for the rice-cattle systems which had expanded during the 1990's in Northeastern Argentina. In 2005, the perspectives of rice reactivation in some provinces –such as Entre Ríos–, are linked to the future soybean's impact in the region. Official analysis suggest that those producers who do not have any low cost irrigation systems

[40] Information of typical yields corresponds to the entire riparian countries.

–such as water direct intake from rivers or water storage in ponds and reservoirs– would tend to produce soybean because it requires less investment than rice cultivation. On the other hand, producers wholly dedicated to rice crop will continue doing so because they look for high yields and bet on higher international price levels to revert present quotation and assure a margin of profit, convinced that with accurate technology rice crop is secure (SAGyPA, 2005 b).

Figure 8.4. Argentina. Typical yields of irrigated agriculture (2001/2002)

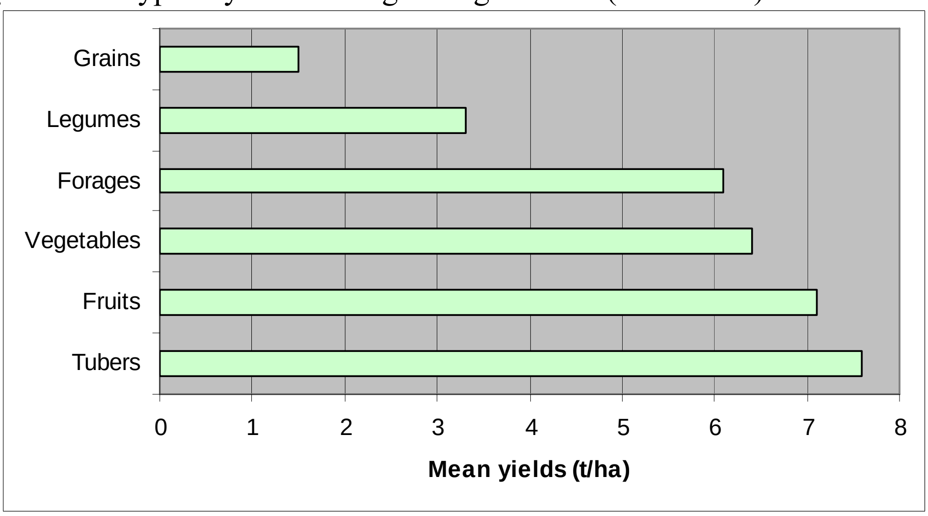


Note: information for entire country.
Source: Based on Fiorentino, 2005.

The use of complementary irrigation in Buenos Aires, Santa Fe, Córdoba and Entre Ríos provinces is also a consequence of favourable market conditions and the good results experimented in irrigation practice. In this case, yields increased between 25 to 40%; there was also a reduction in risks of fall in the production during the drought periods (Calcagno, 2001).

The *Inventario Nacional de Sistemas de Riego* (National Inventory of Irrigation Systems) of Bolivia, shows that tubers, fruits and vegetables were the crops with major yields in the 1998-99 campaign (see Figure 8.5)

Figure 8.5. Bolivia. Typical yields of irrigated agriculture (1998/1999)



Note: data for entire country
Source: Unidad de Desarrollo Sostenible y Medio Ambiente, 2002.

The estimated value of irrigated agriculture was 244.5 million dollars in 1998-99, which represents around 20% of the agricultural GDP. From that value, 44% corresponded to horticultural production, 22% to forage and 18% to legumes. The proportional value of irrigated agriculture (20%) is much higher than that of the irrigated area (7%), which can be explained by the better yields, the possibility of producing during the dry season (winter) and the better season price of various crops (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

Statistical data for Brazil, Paraguay and Uruguay do not distinguish yields of irrigated and non-irrigated crops; they just reveal some particular features related to specific crops that in both cases are of paramount importance in production under irrigation, as is the case for rice. For example, rice yields in Paraguay had reached 3.8 t/ha during the 1990/1991 campaign, whereas a yield of 3.9 t/ha was estimated for the the 2001/2002 campaign (DGEEC, 2003 a). Meanwhile, rice yields in Uruguay topped 6.7 t/ha during the 2003/2004 campaign, being the North and the West Littoral (Artigas, Salto, Paysandú and Río Negro departments, neighbouring the Uruguay River) the regions where the higher yields were obtained (7.7 t/ha) (DIEA, 2005).

Finally, irrigation agriculture in Brazil contributed an estimated 18% of total crop production in weight, and 29% of total farm gate value, since irrigated crops are relatively higher-valued (FAO, 2000 c). In the case of rice crop, the producitivity reached 3.5 t/ha in 2004/2005 campaign in the whole country (CONAB, 2005 b). The southern States (and especially Rio Grande do Sul) have the major productivity, with 5.8 t/ha in the same agricultural campaign (IRGA, 2005).

- Water use efficiency and potential for improvements

Water use and irrigation efficiency problems in the La Plata Basin are generally related to over-dimensioning of irrigation systems –and consequently, their under-utilisation–, scarcity of irrigation works and lack of maintenance of the existing ones. Water losses in the pipelines are another important problem of the irrigation systems. A brief situation of the irrigation efficiency in the riparian countries is presented in the following paragraphs.

There are two great types of irrigation infrastructure in Argentina: the “integrated irrigation” used in the arid and semiarid provinces (such as Salta, Jujuy, Catamarca and Santiago del Estero), based on the so called “irrigation systems”, and the complementary irrigation, typical of humid areas (such as Buenos Aires, Santa Fe or Entre Ríos provinces), based in water extraction and the use of mobile irrigation equipment. The complementary irrigation requires private investments in infrastructure –within the farming establishment–, which is not an obstacle for the development of the irrigated agriculture in humid areas. In fact, this kind of irrigation has been growing during the last years of the XX Century. In spite of this growth, the “integrated” irrigated surface is still much extended –around 1.1 million ha for integrated irrigation and 0.7 million ha for complementary irrigation– and it is more important because it covers the most part of the small producers’ irrigated areas (Fiorentino, 2005).

The irrigation infrastructure is under-utilised in many Argentinean provinces, and this situation affects the irrigation efficiency level. In some cases, such as Santiago del Estero, Tucumán and Formosa provinces, the irrigated area scarcely reaches a percentage of 50% of the available irrigation infrastructure. The efficiency average of piping and distribution systems does not exceed 30%. On the other hand, the irrigation systems with higher efficiency (piping, localised distribution) are insignificant in Argentina as they cover less than 3% of the total irrigated area (Fiorentino, 2005).

The lack of efficiency causes scarcity of water for irrigation; this is not a generalised phenomenon, but it has important effects in many areas of the country. On the other hand, the lack of irrigation works or the lack of maintenance of the existing ones, also impacts on water scarcity. The status of irrigation systems is deficient, mostly in the provinces of the La Plata basin in the arid and semiarid regions of the country. The weakness of the systems in these provinces restricts the irrigation's development, because neither a great nor a better area can be irrigated (Fiorentino, 2005). Water leakages in channels, inadequate water management in agricultural fields and obstruction of drainages due to lack of unlevelled soils are other important limitations to water use efficiency in irrigation (Calcagno, 2001).

The deficient situation of irrigation is also observed in Bolivia. In this case, water scarcity is one of the most important limitations to the development of irrigation, because 40% of the Bolivian territory has six months of water deficit. This situation is worst in the Altiplano and Chaco regions, where the dry season can reach nine months per year (Crespo Valdivia & Bellot Kalteis, 2003). The National Government has developed many irrigation programmes to face these problems, but irrigation is still deficient. The *Estrategia Nacional de Desarrollo Agropecuario y Rural*, ENDAR ((National Strategy of Agriculture, Livestock and Rural Development) developed by the *Ministerio de Asuntos Campesinos y Agropecuarios,* MACA (Ministry of Peasant and Agricultural Affairs), points out that irrigation scarcity is the main limitation of the agricultural sector; irrigation systems are small and provided by rivers with seasonal regime, where the larger water availability coincides with the rainy season (MACA, 2005).

Yields obtained through irrigation are quite below the designed or/and expected efficiency of the irrigation systems. The reason for such situation is essentially the lack of significant efforts during the past years to take full advantage of the existing irrigation works. The objective of a rentable and sustainable agriculture along the time is difficult to reach, since it does not only depend on physical infrastructure or on the efficiency of water piping systems but also on the necessity of training for small farmers responsible of the irrigation system (Crespo Valdivia & Bellot Kalteis, 2003).

Several problems related to investments in irrigation systems were observed since the 1980 decade. One of them is the over-dimension of irrigation works, which is, at its time, related with an over-estimation of irrigation benefits. As a result, some irrigation works are under-utilised, since irrigation systems were constructed following certain criteria –mainly economic and social– that are not real (Crespo Valdivia & Bellot Kalteis, 2003).

The total area of soils suitable for irrigation in Brazil is estimated in 29.6 million hectares; however, only 10% of them are being exploited (Praciano Minervino, 2002). According to the *Agência Nacional de Águas,* ANA (National Water Agency) this huge potential agricultural area would allow widening the food offer with a lesser expansion of the agricultural frontier, enabling the environmental protection of the unoccupied zones (ANA, 2004).

One of the most important problems of the irrigated agriculture in Brazil is water losses in irrigation systems with low-efficiency, traditionally used in those regions with the highest water availability. Meanwhile, in those regions with intensive irrigation and/or restricted water availability, the problems are linked with conflicts among water users. This problem appears in many small basins of Rio Grande do Sul State, where irrigated rice is cropped (Werneck Lima *et al.*, 2000). Additionally, the methodology used to determine crops' requirement of water results in over-dimensioning of irrigation infrastructure (Secretária de Infra-Estrutura Hídrica, 2005).

The *Programa Eficiência na Agricultura Irrigada* (Programme on Efficiency in Irrigated Agriculture) of the *Ministério da Integração Nacional,* MIN (Ministry of National Integration) is the main national policy to face irrigation problems in Brazil. This Programme tends to improve irrigation efficiency through actions such as technical assistance and irrigation systems rehabilitation and modernisation (Secretária de Infra-Estrutura Hídrica, 2005).

Irrigation problems in Western Paraguay are quite different from those identified in the Eastern region. The western region has serious climatic conditions that determine water deficits, while the eastern one has more water availability. In both regions irrigation is scarcely developed, only limited to rice irrigation by flooding near watercourses. The water deficit and the agricultural organisation are both the major limitations to irrigation efficiency. Paraguay is just beginning with a national policy of irrigation development tending to ensure water provision to all the crops along the year (Gamarra Lovera, 2002).

Though the potential irrigated surface in Uruguay is not known, the total surface suitable for rice crop –the main irrigated crop in the country– is estimated in 605,000 ha (64% in the East, 22% in the centre, 8% in the North and the remaining 6% in other areas) without considering those areas which could be transformed by means of drainage systems. Irrigation mainly depends on surface water resources; the frequency of floods and the water level variations in the rivers require storage works and pumping from high platforms to assure water supply.

There are two very different cases concerning efficiency in water transport and the use of irrigation in Uruguay. The first one is the case of fruits and horticulture crops, where more frequent pressurised irrigation is frequent, and where energy consumption and installations cause high efficiency in the practice. The second one is the case of rice, where the existing regime of land-owners (share-croppers who work through short-periods leasing) and crops rotation (rice and forages) are not incentives for efficient water utilisation (FAO, 2000 e).

- Use of treated wastewater

Use of treated wastewater in irrigation is still a not generalised practice in the La Plata Basin. Instead, wastewater is mostly used in the arid and semiarid areas, as a means to fill water requirement in irrigation. A brief situation of this issue in each riparian country is presented below[41].

In Argentina, the use of wastewater is restricted to some initiatives carry out in several provinces of the aridest region of the country, located outside the La Plata Basin. For example, in Mendoza Province, a legal reutilisation of treated wastewater is being carried out since 1996, through the definition of some minimum parameters of effluents' quality, either domestic or industrial. This regulation creates the organisation of Restricted Crops Area

[41] No information was found on this issue in the case of Paraguay.

(know as ACRES) controlled by the *Departamento General de Irrigación* (General Department of Irrigation) of the province. Similar initiatives are being carried out in other provinces with arid and semiarid climate conditions (FAO, 2000 a).

The use of treated wastewater for irrigation in Bolivia is also restricted to the arid areas –the Altiplano and the valleys–. The wastewater can be used direct or indirectly. The former is made through conducting wastewater (either treated or not) directly from sewerages to rural proprieties. In the case of indirect use, the producers take water from rivers where wastewater is discharged into and, thus, a certain residual dilution of wastes can be found in the water. This method is the most common in the country (van Damme, 2002).

Brazil does not have a regulated institutional policy to use treated wastewater. However, the legislation existing at the beginning of 2000s –which institutes the basis for water resources management–, creates juridical and economic conditions to a hypothetical reuse of wastewater as a rationale use and environmental preservation of water. In addition to that, Resolution 20/1986 of the *Conselho Nacional do Meio Ambiente*, CONAMA (National Environmental Council) includes irrigation in the classification of possible water reuse[42]. On the other hand, there are some experiences on the use of treated wastewater in agriculture; for example, in São Paulo State, several experiences related to irrigated agriculture in annual maize, sunflower and hay crops have been carried out by the *Companhia de Saneamento Básico do Estado de São Paulo*, SABESP (Basic Sanitation Company of São Paulo State) and university research centres (Costa Bernardi, 2003).

In Uruguay, the Irrigation Act establishes that the *Ministerio de Ganadería, Agricultura y Pesca,* MGAP (Ministry of Livestock, Agriculture and Fishing) must elaborate technical regulations on the use of treated wastewater to be complied with by the private consumers. Technical rules were established for: a) irrigation water quality; b) qualitative needs of irrigation water; and c) use and management of irrigation water (von Cappeln, 2001), associated to wastewater reutilisation. Nevertheless, it is estimated that Uruguay is still far for require this practise to assure water supply for irrigation; therefore, the costs of these systems are too high to be viable (Yelpo & Serrentino, 2000).

- Utilisation of groundwater

The use of groundwater has a relativly low participation into the irrigated agriculture, if it is compared with the use of superficial waters: only a small percentage of the water used in irrigation come from underground sources. The situation of use of groundwater by each country is presented below.

Groundwater in Argentina was used since the 1950s. Increases in water availability for irrigation have been registered since then, as well as an extension of the cultivated area and an improvement in irrigation efficiency. At the end of the century, FAO estimated that around 25.7 of irrigation was made using groundwater sources in the whole country, being the humid and sub-humid areas the ones with the best groundwater quality (FAO, 2000 a). Meanwhile, only complementary irrigation in Buenos Aires Province demands groundwater in the La Plata Basin (Mugetti, 2004).

[42] Class 1 for vegetable and fruits irrigation and Class 2 for grain and forages irrigation (CONAMA, 1986).

The potential groundwater resource in Bolivia has not been quantified yet. The hydrogeological map of Bolivia shows that the aquifers with the best possibilities of use are located in the Amazon Basin and in two areas of the La Plata Basin: the Pantanal-Chaco and the Altiplano hydrogeologic provinces. Most of water springs of these two provinces provide water to the “bofedales” (cushion peat-bogs) or highland wetlands and most of the lagoons and rivers (Unidad de Aguas y Suelos, 2005).

Although there is no accurate data related to the amount of groundwater used in irrigation, FAO (2000 b) estimated that only a small part of producers use wells and filtrating galleries. For example, the participation of groundwater represents 0.2% of total irrigation in Potosí Department and 0.7% in Santa Cruz Department, considering only water provided by wells (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

Evaluation of groundwater resources is still insufficient in Brazil. ANA estimated that around 80% of the productive volume of water is located in both the Paraná and the Amazon basins. ANA also indicated that more than 200,000 wells are used to supply several activities, including irrigation; the major water volume is used in public supply to households (ANA, 2002).

Groundwater used in irrigation is still not significant in both Brazilian South and Southeast. A proliferation of small irrigation areas devoted to fruits and vegetables –cropped at familiar level– are located in both regions, mainly near the major urban centres. There is only one large irrigation project using mainly groundwater sources in the Verde River valley, in Minas Gerais State (ANA, 2002).

The use of groundwater in irrigated agriculture is not important either in Paraguay or in Uruguay (FAO, 2000 d; Genta *et al.*, 2004). Vegetable crops are the only exception in Uruguay, where near 50% of the irrigated agriculture is supplied by groundwater. The main supply sources are the Raigón aquifer in the South and the Salto aquifer in the North of the country (FAO, 2000 e).

- Effect of irrigation in water quality degradation

Irrigation has produced several problems both in soils and waters, such as salinity, inefficient drainage, erosion and contamination. Considering the situation by country, the available information is not enough to describe the relationship between irrigation and soils and water degradation, mostly in the case of Paraguay. In this country, salinity is considered a threat to biodiversity in some areas of the La Plata River Basin, such as the middle stretch of the Yacaré River sub-basin. However, there are still no references to possible connections among irrigatio practises and the existence of environmental problems, mainly because irrigation is still very scarce in the country (Monte Domecq, 2004).

Salinity and deficient drainage processes are very important environmental issues associated to the traditional irrigation systems in Argentina. There is a highly soluble salt accumulation as a result of a natural process which takes place in the arid and semiarid regions, related to certain climatic, topographic and groundwater conditions, which might be intensified through processes that increase water recharge or obstruct the drainage. Other problems as infiltration leakages in uncovered channels, deficient procedures in management and obstructions in drainage systems, generate important water losses by percolation and runoff which affect the efficiency in irrigation and favour salinity processes (Calcagno, 2001).

Another phenomenon generating environmental problems in Argentina is the expansion and development of complementary irrigation in cereal and oil-crops in Buenos Aires, Córdoba, Entre Ríos and Santa Fe provinces, which is made using groundwater. The expansion has caused overexplotation on the aquifers and other problems related to availability of water flows and water quality due to the intrusion of contaminated water from urban or industrial sources (Calcagno, 2001).

Official estimations considers that 14% of the irrigated area in Bolivia shows risk of salinity, 7% has risk of flooding and 6% has risk of pollution from diverse sources. The major contamination problems appear in Oruro Department, caused by the mining activity which has been developed since several centuries ago. Mining has left not only great environmental liabilities and many deteriorated basins, but also metals and toxic loads –such as bore and arsenic– in water (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

The environmental impacts of the irrigation projects have not been fully studied in the country. For instance, there are not studies on the effects of water diversions on the affected basins or on the impacts of water extraction –which would reach a 100% of water availability in the dry season– on the aquatic fauna and flora. This situation could be partly explained because many of the irrigation projects were designed and carried out before the promulgation of the Environment Protection Act (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

The most important irrigation impacts in Brazil take place in the Uruguay River Basin. Right there, the alteration of water quality related to the use of agrochemicals must be added to the water use conflict between rice irrigation and urban supply. Also soybean, wheat and rice crops in the Upper and Middle Uruguay River basin cause soil erosion and diffuse pollution. Nevertheless, the alteration related to no-till farming has diminished the erosion process during the first years of the 2000s. Finally, reduction in flows as a result of water use for irrigated agriculture has brought about conflicts between Brazilian and Uruguayan producers in the Cuareim/Quaraí River Basin, shared by both countries (Dias Coelho, 2004).

There are no severe problems related to irrigation projects In Uruguay, (von Cappeln, 2002), except in the northern zone –Artigas and Salto departments–, where rice crops were developed in highlands. This area has high risk of erosion, as a result of channelling water systems. Besides, impacts on biodiversity have been increased as a consequence of the construction of reservoirs in areas of native forests which has eliminated the natural habitats of several native species (Genta *et al.*, 2004).

8.1.2. Rain-fed agriculture in the basin

Rain-fed agriculture predominates in all the riparian countries, even in those with higher irrigation development. The hectares devoted to rain-fed crops and their percentage over the total cultivated area are shown in Table 8.5.

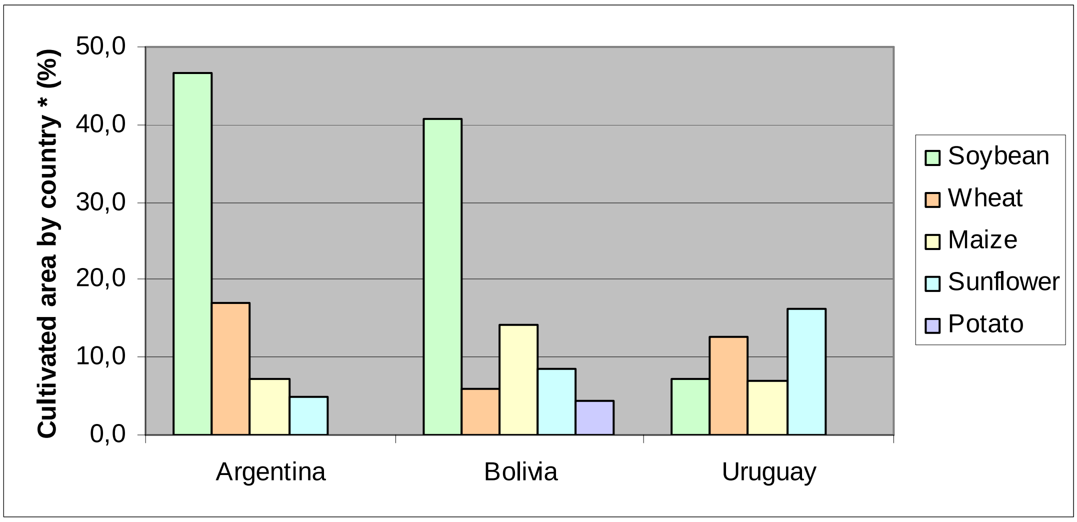
Table 8.5. La Plata River Basin. Percentage of rain fed land (over total cultivated area)

Countries	Rain-fed land (ha)	Percentage over total cultivated area (%)
Argentina	29,431,028	97.3
Bolivia	1,535,638	93.3
Brazil*	243,811,500	92.5
Paraguay	24,815,000	99.7
Uruguay*	1,076,469	83.2

Note: (*) entire country
Sources: INDEC, 2002; INE, 2003; DIEA, 2000; FAO, 2000 c & d.

The areas devoted to rain-fed agriculture are cultivated with several crops, mainly soybean, wheat and maize. Figures 8.6 and 8.7 show the main rain-fed crops and their typical yields in Argentina, Bolivia and Uruguay[43]

Figure 8.6. La Plata River Basin. Main rain-fed crops in Argentina, Bolivia and Uruguay (last available data)



* The percentage is over total rain-fed land.
Source: IICA Argentina, 2004; INE, 2000; DIEA, 2004

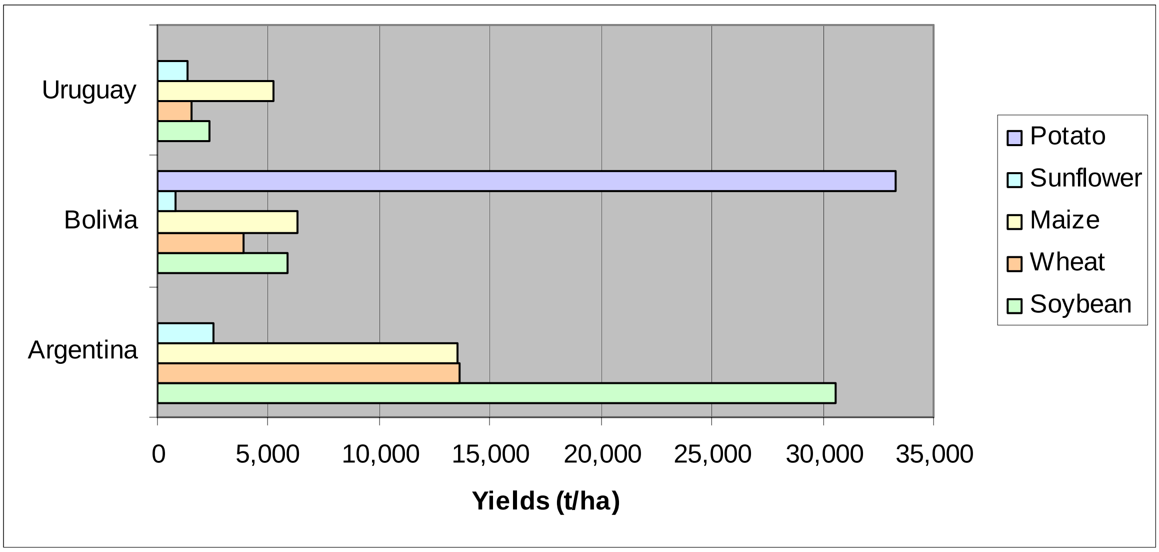
Soybean is the predominant crop in the Argentinean provinces of the La Plata Basin. This crop has registered a huge growth since the 1990's, when progressively replaced other typical crops like wheat or maize. Soybean crops yields are well over wheat and maize's ones.

Soybean crops are also important in the Bolivian departments of the La Plata Basin. They have similar characteristics as the Argentinean production, with a high cultivated area, but crop yields are different, being lower in this case. A typical high-yield cultivated product of the Bolivian departments is the potato, which is not significant in Argentina and Uruguay. This crop, the soybean and other industrial crops, such as cotton and sugar cane, represent 40% of the total production in Bolivia (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

[43] See Annex I for details of the information used in this item.

In Uruguay, the rain-fed agricultural area has been traditionally located in the West (Soriano, Colonia, Río Negro, Paysandú and Flores departments), where more than the 90% of the agricultural area is devoted to rain-fed crops. This area has the soils with the highest agricultural aptitude of the whole country (Area de Estudios Agroeconómicos, 2003).

Figure 8.7. La Plata River Basin. Typical yields of main rain-fed crops in Argentina, Bolivia and Uruguay



Source: IICA Argentina, 2004; INE, 2000; DIEA, 2004.

The predominant oil-crop production is the sunflower; meanwhile the maize is still the typical high-yield crop. The evolution of rain-fed agriculture in the country has been related to the decrease of the harvested area and increases in yields. At the same time, the increases are related to the technological changes in agriculture, such as the renovation of key tools in the agricultural machinery fleet (Area de Estudios Agroeconómicos, 2003).

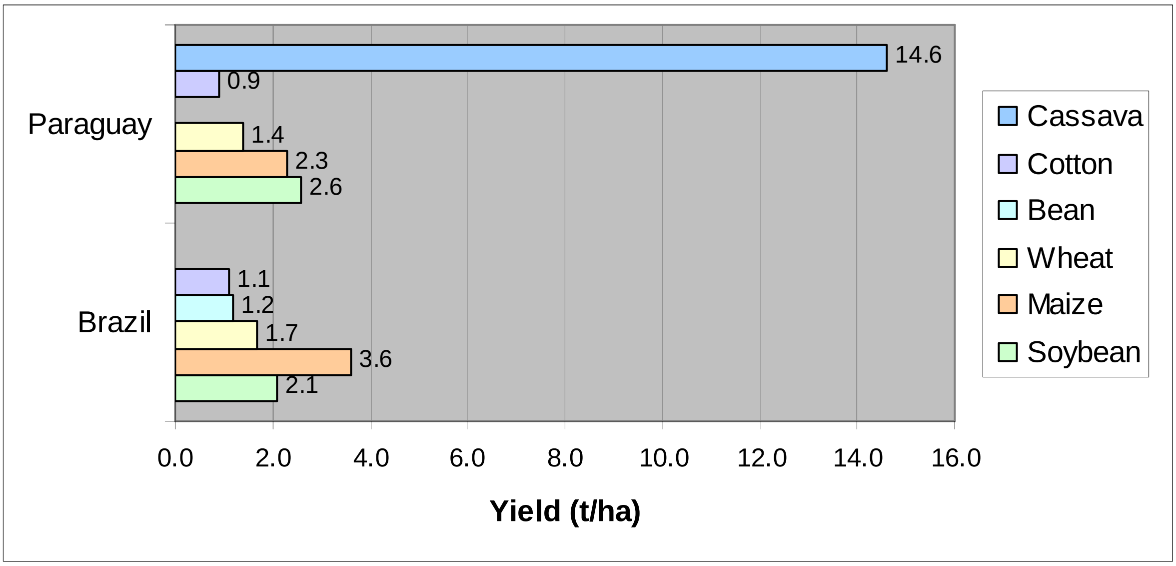
Finally, soybean is also the main crop in Brazil and Paraguay. Table 8.6 and Figure 8.8 show the main crops (rain-fed and irrigated) and typical yields in Brazilian states of the La Plata Basin and in Paraguay, respectively.

Table 8.6. La Plata River Basin. Main crops in Brazil and Paraguay (last available data)

Crops	Cultivated area by country (ha)	
	Brazil	Paraguay
Soybean	21,337,100	1,350,000
Maize	8,651,200	406,365
Wheat	2,755,800	159,342
Bean	803,500	---
Cotton	847,100	297,865
Cassava	---	243,075

Source: CONAB, 2005 a; DGEEC, 2003 a

Figure 8.8. La Plata River Basin. Typical yields in Brazil and Paraguay (last available data)



Source: CONAB, 2005 a; DGEEC, 2003 a

8.2. Water use for livestock, fisheries and aquaculture

8.2.1. Livestock

Cattle-raising is another important activity in the La Plata Basin, developed mainly in those soils which are not apt for agriculture. Considering the area of the five riparian countries, bovines predominate among livestock, except in Uruguay, where ovine is the predominating one. Table 8.7 shows the number of individuals by livestock.

Table 8.7. La Plata River Basin. Main livestock by country (last available data)

Country	**Livestock (number of individuals)**				
	Bovine	**Ovine**	**Porcine**	**Equine**	**Caprine**
Argentina	39,942,200	3,574,800	2,120,600	1,923,000	1,879,800
Bolivia	6,399,906	7,835,442	1,860,107	---	1,714,208
Brazil	132,817,405	5,855,704	22,580,627	3,615,375	---
Paraguay	9,889,000	406,000	1,804,000	358,000	124,000
Uruguay	8,873,637	11,925,139	224,307	415,434	---

Note: Data for Argentinean provinces, Brazilian States and Uruguayan Departments of the La Plata Basin. Data for entire Bolivian territory.
Source: IICA Argentina, 2005; INE, 2001 b; DIEA, 2000; IBGE, 2003 b; DGEEC, 2002

Some estimation on water consumption by each type of livestock can be used for calculating the amount of water used as livestock beverage in the La Plata Basin[44]. According to these

[44] Calculations made by the Brazilian Fundação Getulio Vargas were used by Mugetti (2004) to calculate water consumption by livestock in Argentina. Source: Fundação Getulio Vargas (1998), *Plano Nacional de Recursos Hidricos.* Brasilia, Secretaria de Recursos Hídricos.

estimations, the bovines consume around 50 l/day, the equines 38 l/day, the ovines 10 l/day, the caprines 8 l/day and the porcines 100 l/day. Considering these estimations and the number of individuals by livestock, the volumes of water used in cattle-raising in the La Plata Basin were calculated (see Table 8.8). It is worth to mention that the results of this estimation should be taken as an exercise.

Table 8.8. La Plata River Basin. Estimates of water consumption by livestock (by country)

Country	Water consumption (m^3/day)				
	Bovine	**Ovine**	**Porcine**	**Equine**	**Caprine**
Argentina	1,997,110	35,748	212,060	75,074	15,038,4
Bolivia*	319,995	78,354	186,010	---	13,714
Brazil	6,640,870	58,557	2,258,063	137,384	---
Paraguay	494,450	4,060	180,400	13,604	992
Uruguay	443,681	119,251	22,431	15,786	---

* data for entire country

Source: Based on Mugetti, 2004; IICA Argentina, 2005; INE, 2001 b; DIEA; 2000; IBGE, 2003 b; DGEEC, 2002.

8.2.2. Fisheries

Fisheries resources in continental waters of the La Plata Basin are a relevant source of income and food for the riparian communities living near the major watercourses, such as the Paraná, the Paraguay, the Uruguay and the La Plata rivers. A brief description of this activity by river and country is presented below.

8.2.2.1. Paraná River

In Argentina, fishing in continental waters has not reached an industrial-type development yet; channels of commercialisation and production are still basic and almost informal. However, fisheries have a high social importance because they ensure supply and food for thousands of low-income families living at the river banks –mainly in the Paraná River–. At the beginning of the 2000s there were around 40,000 families living on the use of the resource, either as subsistence or commercial fishery (Mugetti, 2004). This handcraft and small-scale fishery is targeted to the Siluriformes (*Pimelodus maculatus*, *Luciopimedolus pati, Paulicea lütkeni* and *Pterodoras granulosus*) and the Characiformes (*Salminus maxillosus*, *Prochilodus lineatus*, *Piaractus mesopotamicus, Leporinus obtusidens*), which are the most valuable species. Around 35 other species are used as as ornamental fishes for aquariums and 10 species are used as bait.

Along with the commercial fisheries –which represent 90% of the continental fishery in the littoral provinces in Argentina–, there are also fisheries devoted to tourism, both domestic and international. The most valuable species are the goldfish (*Salminus maxillosus*), "surubí pintado" (*Pseudoplatystoma coruscans*), "surubí atigrado" (*Pseudoplatystoma fasciatum*), pacú (*Piaractus mesopotamicus*), common "boga" (*Leporinus obtusidens*), "patí" (*Luciopimelodus pati*), "armado" (*Ptedoras Granulosus*), different species of catfish and "pejerrey" (*Odontesthes bonariensis*). These last species are the most common in the southern part of the basin, in the Paraná, the Uruguay and the La Plata rivers (Mugetti, 2004).

The valuation of fishing activities varies according to the volumes extracted, which are destined to commercialisation without further elaboration or processing. The common practice is the sale of entire or eviscerated fish or, in some cases, cutted in pieces. The highest economic activity is concentrated in the Lower Paraná Basin, and it is based on the fishing of "sábalo" (*Prochilodus sp)*. The activity includes gathering, fish flour production and export to bordering countries such as Bolivia and Brazil (Mugetti, 2004).

In Brazil, fishing is practised in the main rivers, its tributaries and in the reservoirs of large dams, which greatly transformed the fisheries in the La Plata Basin since 1970s, when the large dams started to be constructed. The dams have produced almost the total disappearance of large size migrating species, which were substituted by sedentary species of small size and lesser commercial value.

Commercial fisheries in the Upper Paraná River are professionally developed. The main targets are the large migrating catfishes of the Pimelodidae family (such as "pintado", *Pseudoplatystoma corruscans*), the Characidae family (such as goldfish, *Salminus maxillosus*), the Anostomidae family (such as "piaparas", *Leporinus elongatus* and *L. obtusidens*), the Prochilodontidae and the Erythrinidae families. On the other hand, the sportive fisheries are targeted to the goldfish, "piracanjuba" (*Brycon orbigyanus*), "pacú" (*Piaractus mesopotamicus*), piaparas (*Leporinus obtusidens*) and pintados (*Psuedoplatystoma fasciatum*). These fisheries are restricted to the main river and its tributaries (Dias Coelho, 2004).

Among the reservoirs, Itaipú dam's lake has the most important fishery in the whole Brazilian sector of the La Plata Basin. This reservoir has the best data collection system, which has been developed since the 1980s; thus, it can be said that is one of the best known dams worldwide. The number of fishermen has been constant through the time (around 1,000) and some of 50 different species are captured, 9 of which represent 90% of total captures (Dias Coelho, 2004).

Despite the high importance of fisheries in Itaipú, the yields obtained in Brazilian reservoirs are still far from the international averages. Considering seven major dams in the Paraná Basin[45], the average production is 4.51kg/ha/year, low values compared with, for instance, the 99.5 kg/ha/year obtained in the African reservoirs (Dias Coelho, 2004).

8.2.2.2. Paraguay River

Bolivia has the one of the lowest fish consumption in Latin America, though some relevant fish production is obtained in the Amazon Basin, the Altiplano and the La Plata Basin. In this last case, a commercial fishery is developed in the Pilcomayo River, especially concentrated in the exploitation of "sábalo" (*Prochilodus lineatus*), which represent 90% of the total captures. Fisheries yields are above 2,000 t, with an average of 1,400 t during 1970 and 1980. In the 1990s, fishing diminished as a consequence of hydrologic factors and water pollution related to spills of mining activity residuals (van Damme, 2002). The intense process of sedimentation in the Pilcomayo River and the use of water for irrigation in Argentina and Paraguay are the most important hydrologic factors causing the diminution. The pollution

[45] The seven reservoirs considered are Jupiá, Agua Vermelha, Itaipú (all located in the Paraná River), Barra Bonita, Ibitinga, Promissão and Nova Avanhanava (located in the Tietê River).

related to the residues from mining had its maximum level by the end of 1996, when a large load of heavy metal from the tailing pond of the COMSUR mine spilled near Porco, in Potosí Department. According to some studies, this accident affected the sábalo spawning area, producing long term grave effects (Unidad de Pesca y Acuicultura, 2005).

Along with the "sábalo" (*Prochilodus lineatus*), goldfish (*Salminus maxillosus*) and "boga" (*Leporinus Obtusidens*) are also commercialised in the Bolivian sector of the La Plata Basin. The production in this basin has the least relative participation in the entire country, due to the reduction of yields already mentioned. The participation of the La Plata Basin in the total fisheries production descended from 15% to 8% between 1986 and 1994 (Unidad de Pesca y Acuicultura, 2005).

8.2.2.3. Uruguay River

Fisheries along the Uruguay River are not well studied yet. However, it is known that an intense handcraft fishery has developed along the Brazilian reach of the river (the upper basin). Most the captures are concentrated in the river bed because many land owners forbid the entrance of fishermen to the small lagoons associated to the floodplain, where the "palometa" (*Serrasalmus spilopleura*) is the most important species. On the other hand, the "piava" (*Leporinus obtusidens*) is the most common species and the individuals of bigger size reach more than 8 kg weight. Other important species are the goldfish (*Salminus orbygnianus*), followed by the "patí" (*Luciopimelodus pati*), and the catfish (*Pseudoplatystoma sp.*) the "armado" (*Pterodoras granulosus*) and the "bagre-sapo" (*Rhamdia sapo*) (Dias Coelho, 2004).

Characiformes and Siluriformes –with 400 species– are the most common fish families in the Argentinean-Uruguayan reach of the river; among them, the migratory species are the most important ones (Genta *et al.*, 2004). Fisheries in the Middle and Lower Uruguay River are handcraft and sportive. Handcraft fishermen coming from poor sectors of society and live with their families near the river banks or in the suburban areas, without adequate sanitary and other elementary services (CARU, 2004). According to the *Comisión Administradora del Río Uruguay,* CARU (Administrative Commission for the Uruguay River), almost 1,600 t of fish were captured during 2004. This production is concentrated mostly in the lower reach of the Uruguay River, between the Fray Bentos City and the mouth in the La Plata River. The main target species were the "sábalo" (*Prochilodus lineatus*), which is also the species with the biggest biomass, the "boga" (*Leporinus obtusidens*), yellow "bagre" (*Pimelodus maculatus*), "armado" (*Pterodoras granulosus*) and "tararira" (*Hoplias malabaricus*); other valuable species are goldfish and catfish (CARU, 2004).

8.2.2.4. La Plata River

Important fisheries develop in the La Plata River, near the river banks, between the shoreline and the 12 nautical mile. Thirty eight species are exploited in the Uruguayan commercial fisheries, being the mackerel (*Scomber japonicus*) the most common in the northern part (Genta *et al.*, 2004). The Argentinean commercial fishery develops mostly in the Buenos Aires coastal ecosystem, a stable and diverse system where many species reproduce and breed. About 30 species are exploited in this area, being the white sea bass (*Micropogonias furnieri*) and the hake (*Merluccius hubbsi*) the most important ones; there is also a considerable catch of shrimp (*Pleoticus muelleri*) and prawn (*Artemesia longinaris*) (Boschi *et al*, 2001).

8.2.3. Aquaculture

The aquaculture in the La Plata Basin is remarkably developed in Brazil. The south and south-eastern regions of the country have the highest percentages of fish production, with 55% and 22% of the national total production respectively. Paraná State is one of the main producer of farmed fish, with around 22,416 fish farmers and a fishing production of 17,522 t. The south-eastern region is also the leader in the production of amphibious, with 74% of the production of the entire country (Dias Coelho, 2004).

This activity has grown since the early XX century, when some researches on aquaculture methods began in Brazil. Research intensified in the 1970s and in the 1990s the commercial aquaculture strengthened as a food production activity; finally, in the 2000s, Brazilian aquaculture had an annual growth of 25%. The main species obtained in both rivers and reservoirs are oysters (*Crassostrea gigas* and *Crassostrea rhizophorae*), trout and several species of fish, such as carps (*Cyprinus carpio*), tilapia (*Oreochromis sp*) and "pacú" (*Piaracatus mesopotamicus*) (Ghirardi, 2003).

The development pattern historically fostered in Brazil considers aquaculture as a complementary activity of agriculture and cattle-raising. That is why the industrialised aquaculture products have a large unexploited market in Brazil. According with some studies, the sustainable expansion of fisheries might be produced by the industrialisation of the productive process and the expansion of the consumption basis. The industrialisation processes provide aggregate value and contribute to expand the consumption of the products, being also necessary to produce great changes in food habits (Dias Coelho, 2004).

The achievement of such results should require the resolution of several problems. There are many weak points in the current stage of technologic development of the farmed fish processing industries, mainly in handling, processing, storage, commercialisation, distribution and quality management. Besides, there is no experience on the aggregated value of this productive activity (Dias Coelho, 2004).

In Argentina aquaculture has had a slow growth. In the mid XX century, aquaculture was stimulated through the repopulation of some lagoons in Buenos Aires, Santa Fe and Córdoba provinces, where several species had been reduced by over-harvesting and other causes. This kind of "compensation aquaculture" was carried out generally on autochthonous species with high and popular demand, but whose production is not economically profitable (Mugetti, 2004). Later, aquaculture was promoted again and even though is still a complementary artisan activity for small producers, there has been a significant growth in the commercial activity, mainly during the last years of the century; however, there are still several limitations based on environmental and market issues (Luchini, 2004).

During the XX century, aquaculture was promoted mainly in the continental waters of the country, through the introduction of exotic species, with well known production and breeding techniques. One of the species introduced is the tilapia (*Oreochromis sp*), original from Africa and also highly promoted in Brazil. Among the native species, the "pacú" (*Piaracatus mesopotamicus*) is the most farmed, which reached 31% of the national production in 2001.

The 62% of the total production corresponds to trout (*Percichthys spp*) and the rest to other cultivated species such as oysters, shrimps, prawns and frogs (Luchini, 2004).

Some mistakes have occurred in the practice of aquaculture. The African countries and Brazil were taken as examples to cultivate tilapia, but Argentina has quite different climate and environmental conditions. In the case of "pacú", the difficulties are related with the scarcity of waters with adequate temperature –more than 20º C the whole year, with an ideal temperature between 26 and 30º C– and food with high contents of proteins; another limitation is the difference between fish sizes demanded in the market and those obtained in the Argentinean fish farms (Mugetti, 2004).

In Bolivia the only intensive practice of aquaculture is trout farming in the Altiplano (van Damme, 2002). Meanwhile, in the Bolivian area of the La Plata Basin, the aquaculture is based in common carp (*Cyprinus carpio*). Official data points out that an NGO from Tarija (called "CICA") had a great success in the introduction of common carp farming for self-consumption through the application of efficient methodologies (Unidad de Pesca y Acuicultura, 2005).

National Bolivian institutions of fishing and aquaculture point out that the main limitations to the development of this activity are the lack of institutional support, adequate credit and financing of the activity, together with the lack of training, low fish consumption and scarce informatics infrastructure and bibliography resources. Despite these limitations, official estimations consider that aquaculture would grow in the future, due to the production of "sábalo" (*Prochilodus sp*). "Sábalo" catchments from rivers have been decreasing and consequently there is an increasing import of this fish from Argentina. This situation should be taken as an opportunity to develop "sábalo" farming, since it is the most popular specie both in the Bolivian market and in Bolivians diet (Unidad de Pesca y Acuicultura, 2005).

Aquaculture in Paraguay is still at its beginnings; in fact, only 10% of the potential resource is developed. The total annual production was around 600 and 800 t/year at the beginning of the 2000s, with a demand of 100-120 ha of water. The domestic market is the main target of the production, where the consumption reaches 4.8 kg per capita, including fishes from rivers. Estimations from the *Subprograma de Acuicultura* (Aquaculture Sub Programme) show that there is a productive potential of around 10,000 t/year, which will be able to concrete as far as capital will be invested and productive organisation will be reached (Dirección de Investigación y Producción Animal del Paraguay, 2003).

In Uruguay, aquaculture was promoted in 1975 when the *Dirección Nacional de Recursos Acuáticos*, DINARA (National Directorate of Aquatic Resources) was created together with its regulating law. A first stage of the aquaculture included the definition of policies to develop the activity through investigation. Since the 1990s, a new stage has started, with a high dynamism directed to the promotion and the development of the aquaculture in the private sector. At this stage, DINARA began to receive an increasing number of sowing requests for private farmers.

The main cultivated species in Uruguay are the autochthonous black catfish (*Rhamdia quelem*) and the "pejerrey" (*Odontesthes bonariensis*) and three exotic species of common carp (*Cyprinus carpio*), the grass carp (*Ctenopharyngodon idella*) and the Siberian sturgeon (*Acipenser baerii*). It is expected a future potential development of this activity considering the availability of dams and water sources (Genta *et al.*, 2004).

8.3. Food trade and virtual water

The term "virtual water" refers to the water used in the production process of an agricultural or industrial product and contained in this product. In the case of agriculture, the amount of virtual water required by a crop varies according to particular climates and the use of certain technology (e.g. irrigation). Generally, it is necessary about one to two cubic metres of water (that is, 1,000 to 2,000 kg of water) to produce a kilogram of grain, grown under rain-fed and favourable climatic conditions; on the other hand, it is necessary up to 3,000 to 5,000 kg of water to produce the same amount of grain in an arid country, where climatic conditions are not favourable (Hoekstra & Hung, 2002).

Since the calculation of virtual water is still recent, there are no reports or official information on the riparian countries of the La Plata Basin which consider the balances of virtual water in food trade. Nevertheless, a global report of virtual water trade in agriculture points out the participation of South America (and, more specifically, of the countries of the La Plata Basin) as one of the most important virtual water exporters worldwide.

If one country exports a water-intensive crop to another country, it exports water in virtual form. In this way, some countries support others in their water needs. This is the case of the countries of the La Plata Basin and especially Argentina and Brazil. It could be thought that these two rich-water countries could profit from their abundance of water resources by producing water intensive products for export (Hoekstra & Hung, 2002).

The five countries of the La Plata Basin are included in the top-30 list of countries in terms of net virtual water export of the period 1995-1999. Table 8.9 shows the gross virtual water exports and imports, the net balance and the position of the countries in the world ranking.

Table 8.9. La Plata River Basin. Virtual water trade in agriculture by country (1995-1999)

Countries	**Gross virtual water trade (10^6 m^3)**		**Net balance (10^6 m^3)**	**Position in World's ranking**
	Exports	**Imports**		
Argentina	233,776.8	7,434.7	233,042,1	4
Brazil	160,858.8	115,807.8	45,051.0	10
Paraguay	43,840.4	1,714.9	42,125.5	11
Uruguay	16,116.4	4,109.0	12,007.4	17
Bolivia	8,660.5	3,374.2	5,286.3	22

Source: Based on Hoekstra & Hung, 2002.

Brazil has net export by considering all the period, but net import of virtual water in one or more particular years (Hoekstra & Hung, 2002).

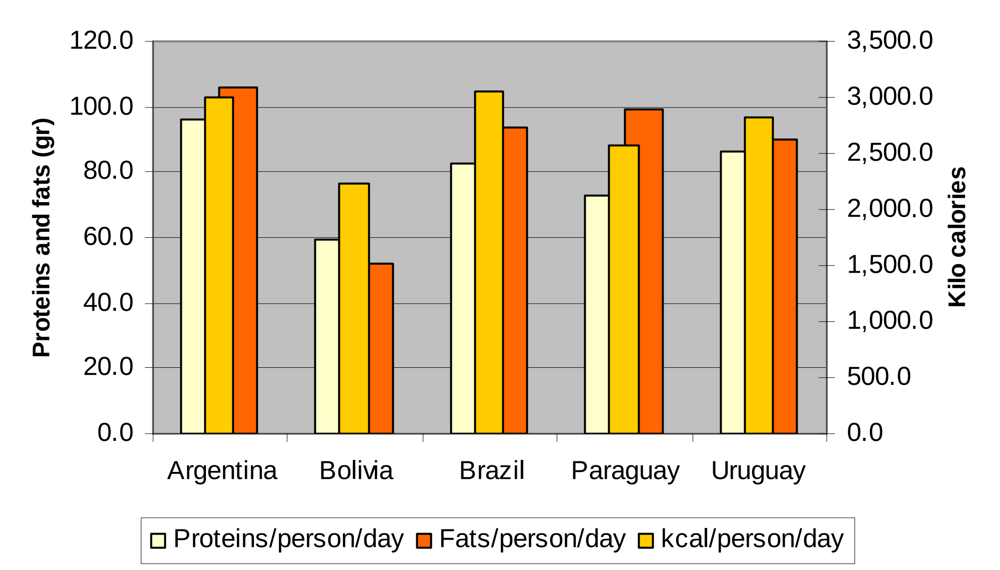
Considering the five countries, the difference between exports and imports reaches a net balance of 330,812.3 10^6 m^3 of water. This amount represents around 90% of the net export volume of the whole South America, which is the second region of the world in the ranking of international trade volume. Exports are mainly to Western Europe, Central and South Asia, Middle East and North Africa; imports come from North America, North Africa, Southeast Africa and Oceania (Hoekstra & Hung, 2002).

8.4. Goals and programmes related to food

8.4.1. Per capita food consumption

Information on this issue is based in FAO statistics with data by countries for year 2002. Figure 8.9 shows the daily consumption of calories, proteins and fats per capita, at the beginning of the 2000s.

Figure 8.9. La Plata River Basin. Daily consumption of calories, proteins and fats per capita, by country (2002)



Source: FAO, 2005 b

Bolivia has the lowest indicators. Nevertheless, the average of daily calories/proteins/kg has been growing since 1986-90 till 2003. For example, 2,046 kg/calories per capita were consumed between 1986 and 1990 and the average grew to 2,241 calories in the 1996-2000 period. The most important changes in food habit include consumption of rice, vegetable oil and meat. There is also a lower tubercle consumption (especially potato), maize and animal fats; this situation shows an important change in the Bolivian diet which has been producing since the 1990s (Crespo Valdivia & Bellot Kalteis, 2003).

8.4.2. Major programmes in progress and future plans

National institutions are developing several plans and programmes tending to improve the current food-related issues in the five countries. The main ongoing projects are shown briefly below, by country (except Paraguay).

- Argentina

Programa de Seguridad Alimentaria "El hambre más urgente" (National Food Security Programme, "The most urgent hunger"): This programme is being carried our by the *Ministerio de Desarrollo Social* (Ministry of Social Development). It consists in a state policy on food, since it aims at increasing the population's quality of life, beyond responding to the emergency situation. It also includes the improvement of both health and nutrition. It is oriented to families who live in disadvantaged social conditions and in a situation of nutritional vulnerability. Its objectives are to provide food assistance; facilitate self-production of food in the families; carry out actions in education on food and nutritional; and develop actions focussed on groups at dietary risks, among others. Besides familiar assistance, school dining halls, orchards and family-owned farms and service networks are assisted as well. Also, health care is provided to pregnant women and children. This programme has been developed since the enactment of the Law that promotes it in 2002 (Ministerio de Desarrollo Social de la Nación Argentina, 2005).

Programa Calidad de los Alimentos Argentinos, PROCAL (Argentine Food Quality Programme): This programme is being developed by the Secretaría de Agricultura, Ganadería, Pesca y Alimentos de la Nación, SAGPyA (National Secretariat of Agriculture, Livestock, Fishing and Food). The PROCAL contributes to guarantee food innocuousness and improve its insertion in the foreign market through an intensive management and the promotion of quality control. The methodology of the Programme is based in the selection of a group of small and medium enterprises according to pre-established methods. The selected enterprises are assisted to carry out a common diagnostic to detect specific situations and the concrete measures to be taken. Once this stage is accomplished the next step is the reformulation of the Project to obtain the corresponding certification with the support of foreign financing sources (SAGPyA, 2005 a).

- <u>Bolivia</u>

Estrategia Nacional de Desarrollo Agropecuario y Rural - ENDAR ((National Strategy for Agriculture, Livestock and Rural Development): The ENDAR, developed by MACA, is responsible for defining the guidelines of the national food policy. Such policy endeavours to enable the population to reach food security, focussing on actions towards improving levels of availability, access and use of food for the country's most vulnerable population (MACA, 2005).

Programa Nacional de Nutrición e Inocuidad Alimentaria, PRONIA *(National Programme for Nutrition and Food Innocuousness)*: This programme is in charge of the *Ministerio de Salud y Deportes,* MSD (Ministry of Health and Sports). It foresees the improvement of nutritional conditions of the Bolivian population by means of direct and integrated actions which allow withdrawing the prevalence of malnourishment among the population and especially, the groups at risk (Ministerio de Salud y Deportes de Bolivia, 2005 b).

Programa de Apoyo a la Seguridad Alimentaria, PASA (Food Security Support Programme): This programme is financed by the European Commission and it is carried out through a national implementing agency. The first phase was developed between 1997 and 2004. Recently, an agreement has been signed for a second phase, which should be developed between 2005 and 2009. The main target of PASA is the promotion and improvement of the availability and access to food for the most vulnerable population (Gobierno de la República de Bolivia & Comisión Europea, 2005). This objective lies within the food policy framework put forward by ENDAR. According to that, PASA will focus on supporting the sectoral reform, developing a new financial policy and improving agricultural and rural public investments (Ministerio de Relaciones Exteriores y Culto de la República de Bolivia, 2005).

- Brazil

Fome Zero (Zero Hunger): It is a policy of the federal government, aiming at ensuring the right to adequate diet patterns, prioritising groups of population with limited access to food (Presidencia da República Federativa do Brasil, 2005). By means of multiple actions and specific programmes to combat poverty, *Fome Zero* seeks to guarantee the social inclusion of over 11,000,000 families. The federal government makes partnerships with state governments and NGOs so as to meet the needs according to local scenarios. At the beginnings of 2000, 31 actions and programmes were being carried out in accordance with four articulating axes: expansion of food access, strengthening of familiar agriculture, promotion of income-generating processes and mobilisation and social control. Examples of these actions are:

- *Programa Bolsa Familia (Family Assistance Programme)*: Through this programme the federal government grants financial subsidies to the neediest people.

- *Programa Banco de Alimentos (Food Bank Programme)*: This programme is an initiative to reduce food wasting. The Bank works as an intermediary between food trading, storage and processing companies and the assistance entities, by collecting donations of food –either non-traded or close to expiration date– for later distribution.

- *Agricultura Urbana (Urban Agriculture)*: The main target of this programme is to provide access to fresh food of high nutritional values to the disadvantaged population. To meet this goal, the creation of community orchards is encouraged.

Other programmes under development are*: Sistema de Vigilância Alimentar e Nutricional,* SISVAN (Surveillance System of Food and Nutrition); *Alimentação e Nutrição de Povos Indígenas* (Feeding and Nutrition of Indigenous Peoples); *Educação Alimentar, Nutricional e para Consumo* (Alimentary, Nutritional and Consumption Education); *Alimentação Saudável* (Healthy Food Patterns).

- Uruguay

Plan de Atención Nacional a la Emergencia Social, PANES (Plan for National Care of Social Emergency): Promoted by the *Ministerio de Desarrollo Social* (Ministry of Social Development), the PANES aims at providing responses to the various problems within the context of social emergency the country was undergoing. Such social emergency is characterised by extreme social vulnerability conditions in which a considerable portion of the Uruguayan population is immersed. PANES' target population comprises all poverty-stricken[46] inhabitants. PANES seeks to build consensus in a participative and collective way, in order to guarantee coverage of basic needs to vulnerable sectors, stop the acute impoverishment risk and generate conditions for the complete use of social rights (Ministerio de Desarrollo Social del Uruguay, 2005).

Seven plans are included in the PANES. The *Plan Alimentario Nacional,* PAN (National Food Plan) is specifically engineered to solve food matters. Likewise, the *Plan de Emergencia Sanitaria* (Sanitary Emergency Plan) is focussed on critical health issues. The remaining

[46] According to the definition adopted in Uruguay, population who have not enough income to cover basic needs of daily food is considered as indigent.

plans are oriented towards solving social needs for education, labour, income and housing. These plans are ongoing, having taken care of over 25,000 households as at November 2005 (Ministerio de Desarrollo Social del Uruguay, 2005).

8.4.2.1. Progress toward MDG goals

One of the eight main goals defined by the Millennium Declaration signed by the United Nations members in 2000 includes poverty and hunger reduction; this objective has a strong relationship with the general issue of this chapter. Information provided by different sources remark that Latin American countries are left behind in the accomplishment of this goal, considering the strong economic crisis registered in the beginnings of 2000s. A short description based on the last reports prepared by the five riparian countries is presented below.

In Argentina, poverty and hunger have been reduced in a 20%. The extremely high indigence levels in the country caused the prevalence of infant malnutrition by the end of 1990s. The main problem of children was their low height and their deficit in certain micronutrients, such as iron. The social emergency of 2001-2002 caused a million people living in insecure food conditions, since more than the 25% of the population have no enough incomes to cover the nutritional requirements. Consequently, an increase in the prevalence of malnutrition among children (mainly under five years old) is expected, if public initiatives do not compensate the deterioration in the lowest incomes. In order to face this scenario, the National Government has restructured the social plans and concentrated all the economic resources in a Programme to attend food needs. Besides, new economic resources were sent to the Provincial Governments and to several NGOs aimed to help poorest families with severe problems to attend their food needs. These actions tended to strengthen the initiatives of creation of infant, scholar and communitarian dining places, the self-production of meals through communitarian farms and the food distribution among the poor population (Presidencia de la Nación Argentina, 2003). Other issues included were the assistance to pregnant women and healthy children and the management of decentralised funds (Ministerio de Desarrollo Social de la Nación Argentina, 2005).

As regards Bolivia, the last Millennium Goals advance report points out the scarce possibilities to reduce poverty and eradicate hunger within the terms agreed in the UN document, due to the severe economic crisis produced at the end of the 1990s and beginning of the 2000s, which impacted on the economic development and produced an increase in poverty levels. In relation to hunger, the crisis produced a decrease in the daily food consumption among the poorest population; this group consumes around 30% of the daily kilocalories recommended by FAO –that is 2,100 kcal/day–. This situation results in a chronic malnutrition affecting 50% of the under-five years old children in the poorest households (Gobierno de la República de Bolivia, 2002).

The most important challenge to reduce poverty and hunger according to the Millennium Goals is the implementation of the *Estrategia Boliviana de Reducción de la Pobreza*, EBRP (Bolivian Strategy for Poverty Reduction), up to 2015. The EBRP is an integral programme to reduce poverty which implies institutional changes, a high grade of coordination among those responsible of poverty reduction, civil society co-responsibility and a capacity to generate and manage resources. So far, the official country position admits few possibilities to achieve the target even though the actions foreseen in the EBRP are accomplished in due time, since there is a necessity to have an economic growth of 5% or 6% annual increase rate in a 15 year time, that is, between 2000 and 2015 (Gobierno de la República de Bolivia, 2001).

Brazil had achieved important advances regarding poverty reduction, but a great part of the population still lived in extreme poor conditions by the end of 2004. The percentage of poor people –measured according to different methods– was more or less constant since the mid 1990s. Another useful indicator, the share of poor population in food consumption, shows also signs of improvement, even though the income distribution is still very unequal, mainly in the Northeast of the country. Finally and regarding hunger eradication, there had been important advances mainly as regards the relative weight of the infant malnutrition, which diminished around 70% between 1985 y 1996. Nevertheless, the country has over 1,000,000 children with weight deficit. As far as this indicator severely expresses the situation of insufficient nutrition, it shows, in an overwhelming way, that hunger is still a serious problem in Brazil. The reason is not the lack of food –in fact, Brazil produces more food than required by its population– but the impossibility of a large population sector of accesing high quality food (Governo da República Federativa do Brasil, 2004).

To face this situation, the federal government implemented different actions. The *"Fome Zero" Plan* ("Zero Hunger" Plan) is ongoing since 2005, with the aim to treat the causes of the problem through the implementation of diverse policies: rent transfers to poorest families; employment and rent generation; attacking of hunger and promotion of food access; emergency policies for the most vulnerable population. Besides, the full participation of the society is promoted to solve this problem (Governo da República Federativa do Brasil, 2004).

In Paraguay, the latest document on Progress toward the Millennium Goals does not consider either that it will be possible to reduce hunger and poverty. In fact, both the poverty and indigence levels increased between 1995 and 2001: the percentage of poor people increased from 30 to 35%, whereas the amount of indigent people climbed from 14 to 16%. Of the total of people in a situation of indigence, 76% live in rural areas. As regards hunger eradication, chronic malnutrition problems have not decreased, since the prevalence of low weight for age was 4.5% in 2001, whereas in 1990 the percentage did not reach 4%. The incidence of malnutrition is higher among women and in poor households where child malnutrition is three times higher than in non-poor households (Sistema de las Naciones Unidas en Paraguay, 2003).

As a challenge to overcome the present situation, the government of Paraguay foresees the implementation of a social protection and advancement programme as a short-term measure. The Plan for the first 100 days of the government that took office in 2003 prioritises the fight against poverty, which is connected with existing strategies such as the *Estrategia de Reducción de la Pobreza y la Desigualdad,* ENREPD (Strategy to Reduce Poverty and Inequality). As long-term measures, the government proposes implementing state policies intended to achieve macroeconomic stability, encourage investment, foster education and health, among others (Sistema de las Naciones Unidas en Paraguay, 2003).

Finally, in Uruguay the situation is similar to the rest of the countries. Even thought there is a low incidence of indigence, the percentage of the population in such a situation grew from 1990 to 2002, first slowly (until 1994) and speeding up later. The percentage of people living in a poverty situation rose as well. Chronic malnutrition, as a measure of the situation in terms of hunger eradication, has accompanied the trend of poverty rates; after a decreasing trend between 1990 and 1995, there was a reversal and a consequent increase in the amount of children with chronic malnutrition (ONU Uruguay, 2003).

To face the situation, the Uruguayan government implemented the *Plan de Seguridad Alimentaria* (Food Security Plan) and increased benefits to the needy population through different programmes coordinated by the *Instituto Nacional de Alimentación,* INDA (National Food Institute) (ONU Uruguay, 2003).

8.4.3. Agricultural policies

The institutional structure of the agricultural sector in Argentina is integrated by the SAGPyA and other institutions, such as the *Instituto Nacional de Tecnología Agropecuaria*, INTA (National Institute of Agricultural Technology). The SAGPyA assists the national authorities in the design of policies and in the development and coordination of programmes and other initiatives aiming to define the priorities in agriculture production. The objectives of the SAGPyA are, among others:

- improving of competitiveness of the productive sector;
- promotion of agriculture and livestock production, taking into account the rationale and sustainable utilisation of the resources, and
- monitoring the performance of crops in each agriculture's campaigns.

The most remarkable SAGPyA's programmes and projects are those aimed to the development of agriculture oriented to favour the inclusion of small and medium farmers in the national economy, and consequently, to alleviate poverty in rural areas. Some of these programmes are the *Programa de Servicios Agrícolas Provinciales*, PROSAP (Programme of Provincial Agriculture Services), the *Programa Social Agropecuario*, PROINDER (Social Agricultural Programme), the *Proyecto de Desarrollo Rural de las Provincias del Noreste Argentino* ProderNEA (Project on Rural Development of Northeast Argentinean Provinces), the *Programa de Apoyo a los Pequeños Productores* (Small Producers Support Programme), Cambio Rural (Rural Change) and Prohuerta; all these programmes have different scopes and objectives (SAGPyA, 2005 a).

INTA is fully dedicated to research and agriculture extension. The actions of INTA aim to accelerate the rural development through automation and improvement of the agricultural enterprises and rural life. INTA depends on SAGPyA, but has autonomous operation and financing. INTA's main goal is to contribute to competitiveness of the agricultural, forestry and agro industrial sectors along the national territory, in an ecological and socially sustainable context. This institution also develops research programmes on animal health, biotechnology, vegetable protection and environmental management (INTA, 2005).

In Bolivia, the MACA designs and performs the policies of the agricultural sector. The current policy is framed in the ENDAR. This is a wide programme, which includes all the sectoral issues –and, among them, the food security policy–. MACA led the agreement process of ENDAR, with the participation of the civil society through a widely participative methodology. A commitment agenda has been agreed between the National Government and the stakeholders related to rural and agricultural development. The ENDAR is oriented to raise the contribution of the agricultural sector to the National Gross Domestic Product, which has remained in 14% since the first half of 1990s; this percentage shows, in a conclusive way, the low productivity of the rural labour force, with low levels in several areas and a precarious production base (MACA, 2005).

In Brazil, the *Ministerio de Agricultura, Pecuária e Abatecimento*, MAPA (Ministry of Agriculture, Livestock and Supply) has the mission to formulate and implement policies aiming to develop the agribusiness, integrating different aspects: technological, marketing, organisational and environmental. This development is basically addressed to national and foreign consumers promoting food security, the generation of income and employment and the reduction of social inequalities. The pluri-annual Plan 2004-2007 and the Agriculture and Livestock Plan are the framework for the different actions and strategies of MAPA in the middle 2000s and the short term period (Ministerio de Agricultura, Pecuária e Abastecimento, 2005).

In Paraguay, the *Ministerio de Agricultura, y Ganadería.* MAG (Ministry of Agriculture and Livestock) is implementing the *Plan de Desarrollo Agropecuario y Rural 2004-2008* (Agriculture and Rural Development Plan 2004-2008), which has wide development goals in the sector. The Plan includes a deep institutional reform, involving the integration of public and private efforts and the participation of the main stakeholders. It also includes the organisation of products' trade oriented to all the markets, assuring the correct insertion of the producers. The Plan also foresees the increase of food security in the country and the territorial rearrangement of rural population, through policies aimed to improve the land tenant and ownership structure (Ministerio de Agricultura y Ganadería del Paraguay, 2003).

As regards plans and/or programmes related to the promotion of agriculture, the *Dirección Nacional de Coordinación y Administración de Proyectos*¸ DINCAP (National Directorate of Project Coordination and Administration) of the MAG, has carried out projects and/or programmes aimed to the technological development of the small farmers, such as the *Programa de Tecnificación y Diversificación Campesina* (Programme of Rural Modernisation and Diversification) (Dirección Nacional de Coordinación y Administración de Proyectos del Paraguay, 2005).

In Uruguay, the agricultural authority is the MGAP. Its main mission is to contribute to a permanent development of the agricultural, agro-industrial and fisheries sectors, promoting their insertion into foreign markets, framed in the sustainable management and use of the resources (MGAP, 1999). In order to achieve its objectives, the MGAP is carrying out several programmes and projects; one of them is the *Programa de Servicios Agropecuarios* (Programme of Agricultural and Livestock Services), which has diverse components focussed on extension activities and technological transference. Other projects are aimed to the development of cattle-rising through actions such as strengthening of the relationship between producers and the national and local authorities.

8.4.3.1. Reforming irrigation

In Argentina, irrigation has strong difficulties in several aspects, which affect its economic, social and environmental performance. The main difficulties are related to the quality of the institutional irrigation management and to the economic valuation of water for irrigation. Other issues have to do with the lack of technical capacity among producers, the lack of funding and the inadequate conditions of the irrigation infrastructure (Fiorentino, 2005).

The rise of the application and conduction joint efficiency –which is up to percentages between 10% and 20% in most of irrigated areas– would enable increases in the production and its value at rates of 10% to 20% in many irrigated areas. In all cases, the irrigated land would increase, the irrigation methods would improve and, therefore, not only the efficiency would improve, but also the jobs would increase. A possible strategy to improve the irrigation in the country should be related to the following steps (Fiorentino, 2005):

1) decentralisation of irrigation financial and operative planning;
2) determination of a most accurate water price for irrigation;
3) improvement of management quality;
4) formulation of a short term or "emergency" investment programme, aimed to recuperate the most deteriorated components of the national irrigation infrastructure;
5) extension of research activities on irrigation.

The ENDAR proposed by the MACA in Bolivia includes the promotion of irrigation through the provision of infrastructure which allows adding around 50,000 ha to the total irrigated land existing at the beginnings of 2000s. The proposed guidelines to achieve this goal include, among others: the use of the available water resources, through the implementation of integral irrigation projects framed in basin management concepts; the rehabilitation of non-utilised irrigation systems, including their technological improvement; the promotion of technical irrigation; and transfer activities and training of farmers. These guidelines will be executed through the implementation of diverse instruments, such as the *Servicio Nacional de Riego*, SENARI (National Irrigation Service) and the *Servicios Departamentales de Riego*, SEDERI (Departmental Irrigation Services), which would be coordinated with municipalities and irrigation producers associations, the national and departmental plans of irrigation and the national programme of basins (MACA, 2005).

At the beginning of 2000s, MACA coordinates the following irrigation policies:

- *Programa Nacional de Riego, PRONAR (National Programme of Irrigation)*: The PRONAR began in 1996[47]. This programme tends to achieve an institutional and legal planning of irrigation water which favours the entire society and mainly, the rural families. The different PRONAR's components aim to incentive the investments in infrastructure, to support the water resources planning and to achieve institutional strengthening. The active participation of PRONAR' stakeholders (the rural communities) are also foreseen, through a decentralised structure coordinated by MACA.

- *Políticas Públicas de Riego (Public Policies of Irrigation)*: These policies integrate the ENDAR and are a result of the execution of the PRONAR. The main goals of these policies are the increment of the irrigated land area, the improvement of water and land use promoting the construction of a good quality infrastructure, the efficient utilisation of technologies and the strengthening of users' self-management capacities. In other words, these initiatives involve all the aspects included in the functioning of the irrigation management system. This implies, in first place, the existence and validity of a legal and institutional framework which would support the irrigation

[47] PRONAR, financed by the IDB and GTZ, finished in 2003. However, the report made by MACA in 2005 informs that the Project is still going on.

management with its different components (planning, promotion, investments in infrastructure and technology, operation and maintenance, training and technical assistance in irrigation systems). These components operate under the sustainable use of water and land, taking into account environmental safe actions (Unidad de Aguas y Suelos, 2005).

- *Plan Nacional de Riego (National Plan of Irrigation)*: Developing at the beginning of 2000s, this Plan foresees the addition of an average of 8,000 ha/year as irrigated land, and the continuous improvement of the existing systems, with an investment of around USD 50,000,000 per year. This plan is developed in parallel with the departmental irrigation plans.

The lack of stable political and budget guidelines affect the regular development of irrigation in Brazil. Except during the existence of the *Ministério Extraordinário da Irrigação* (Extraordinary Ministry of Irrigation) the irrigation sector has always been an appendix of any ministry. This situation has not allowed the development of an integrated management organisation in irrigation. At the beginning of 2000s, with the last changes in the govermental structure, the management of the programmes and plans on irrigation and drainage are carried out by the *Departamento de Desenvolvimento Hidroagrícola* (Department of Hydro-agricultural Development), dependent on the *Secretaria de Infra-estrutura Hídrica* (Secretariat for Water Infrastructure) of the *Ministério da Integração Nacional* (Ghirardi, 2003).

The following irrigation policies are being developed in the 2000s:

- *Programa Desenvolvimento da Agricultura Irrigada (Programme on Irrigated Agriculture Development):* The execution of this Programme is decentralised and the municipal and State governments and other institutions related to the Ministry are the direct responsible for the execution of the actions, while the *Secretaria de Infra-estrutura Hídrica* (Secretary of Water Infrastructure) coordinates and supervises them. The annual and multi-annual plans are elaborated according to the needs identified by the State and municipal governments and other institutions. The Programme considers diverse actions, such as support to States and municipalities in the elaboration of master plans, as a way to articulate the Programme's actions in the regional development vision; studies and projects; support and institutional strengthening; execution of works and purchase of equipments. The actions are executed according the priority criteria established by the *Secretaria de Infra-estrutura Hídrica* and they incorporate the association of public and private sectors in the implementation of irrigation agriculture projects.

- *Plano Nacional de Irrigação e Drenagem, PLANIRD (National Plan of Irrigation and Drainage):* This Plan aims to guide the investments of Federal Government in the 2000-2005 period. The objective for the first period consisted in putting into production all the public projects (federal and state), including those areas not yet considered for specific planning. Investments on studies as a preparation of projects were also foreseen in the same period, as a way to establish the goals for the second period. Cultivation of 500,000 ha was foreseen for the second five-year period, with a total investment of 5,5 USD billion. The water demand would increase to 42 billion m^3/year at the end of the second period (Ghirardi, 2003). The implementation of PLANIRD tends to give dynamism to the irrigation sector, as a way to increase the irrigated area per capita substantially, –which is one of the lowest worldwide– and to increase the contribution of irrigated lands in the food offer. A significant increase in irrigated agriculture is expected in the Southeast, Northeast and mainly the Centre-east region. (Ghirardi, 2003).

- *Programa Eficiência na Agricultura Irrigada (Programme on Efficiency in Irrigated Agriculture):* The Programme contemplates a wide set of actions, including: rehabilitation and modernisation of irrigation systems; technical assistance; support to the competitive insertion of the irrigated agricultural products in national and foreign markets; technical and administrative training of the producers; education of specialised personnel of middle and superior levels. The actions will be executed in association with the state and municipal governments, other related institutions and rural producers. The conditions to start with the execution of the Programme are: the knowledge of the localisation and characteristics of all rural producers' systems which use irrigation and the establishment of an interactive information system between public and private sectors.

- *Programa Transferência da Gestão dos Perímetros Públicos de Irrigação (Transfer of Management of Public Irrigation Perimeters Programme):* The Programme has a decentralised execution. The state and municipal governments, the institutions linked with the Ministry and the users of the irrigation systems (congregated in "irrigation districts") are the direct responsible for implementing the actions. The Programme has multiple activities and actions: bidding of projects' land portions; selection, organisation and re-organisation of producers (irrigation district, association and/or cooperatives); awareness and training of producers (on irrigated agriculture, agricultural management, environmental management, association, project management, systems' operation and maintenance); rehabilitation and modernisation of systems; technical assistance; co-management and management transfer.

Other important irrigation programmes developed during previous decades were:

- *Programa de Aproveitamento Racional de Várzeas Irrigadas,* PROVARZEAS (Programme for Rational Development of Irrigated Basins) started in 1981, which has implemented a million irrigated hectares in the country till the end of the 1980s;

- *Programa de Financiamento de Equipamentos de Irrigação,* PROFIR (Programme for Financing of Irrigation Equipment) started in 1983, which promoted mechanised irrigation systems –central pivot, conventional and localised–;

- *Programa Nacional de Irrigação,* PRONI (National Programme of Irrigation) begun in 1986; and

- *Programa de Irrigação do Nordeste,* PROINE (Northeast Irrigation Programme), started in 1986.

The difficulties of the Federal Government in maintaining permanent investment's policies in the sector caused the end of all of these programmes (Ghirardi, 2003).

Paraguay is at the first stage in the implementation of a national irrigation policy, which assure the water provision to agricultural production along the whole year. The traditional crop systems in Paraguay depend on rainfall water, which is considered as an indicator of the absence of water resource management. There were several antecedents of irrigation through sprinkling and dripping pilot projects, which were carried out in the Concepción Department between 1995 and 2000, benefiting 1,550 poor families. More recently, other antecedents were the irrigation projects developed in the San Pedro, Coronel Oviedo, Caazapa, Itapúa, Cordillera and Paraguari departments (FAO, 2000d; Gamarra Lovera, 2002).

Irrigation in Uruguay is being subject of deep changes since the 1970s, through the improvement in production techniques in most of the irrigated crops. The incorporation of different forms of localised irrigation are stand out among them, such as micro sprinkling and dripping. This irrigation method contributes to make a more rationale and efficient utilisation of available water for irrigation and allows the use of other techniques to increase crops quantity and quality (von Cappeln, 2001).

The institutions related to the use of water for irrigation are the MGAP and the *Ministerio de Transporte y Obras Públicas,* MTOP (Ministry of Transport and Public Works), through its *Dirección Nacional de Hidrografía*, DNH (National Directorate of Hydrography). The main project developed in the beginning of 2000s was the *Programa para el Manejo de Recursos Naturales y Desarrollo del Riego,* PRENADER (Natural Resources Management and Irrigation Development Programme). This Programme was developed between 1996 and 2001 by MGAP representatives, the MTOP and rural producers with the assistance of the World Bank.

The PRENADER aimed to impulse irrigation expansion through the execution of private works and to promote the associations of irrigation's producers. Most of the components of the Programme were being used for rice cultivation; several official controls framed in the Irrigation Law supervise this cultivation, as a way to avoid soils degradation. The main achievements in the end of XX century were possibly obtained through PRENADER. These achievements were: the construction of 1,400 irrigation perforations to meet an annual water demand of 11,500,000 m^3 to irrigate 4,200 ha; and the construction of 850 works (such as dams, reservoirs, excavated tanks and ponds) to provide 27,100,000 m^3 of water to irrigate an area of 30,626 ha (von Cappeln, 2001). According to official information, the Project would continue and its second phase would call "PRENADER II".

On the other hand, the *Instituto Nacional de Investigación Agropecuaria,* INIA (National Agricultural and Livestock Research Institute) was developing some research lines to determine water management practices which allow the producers making a more efficient use of the resource, considering the interaction of irrigation with the remaining management factors (crop varieties, fertilisation, soils and crop types, diseases). In this context, INIA points out several recommendations in irrigation management for different crops and different environments. On the other hand, irrigation sources in crops such as fruits, vegetables, citric and vineyard have been replaced by other more efficient irrigation techniques, such as sprinkling, dripping and micro-dripping (von Cappeln, 2000).

8.4.3.2. Pricing of water

Official institutions of Argentina have accepted that pricing allocation mechanisms do not recognise the economic value of water. In fact, irrigation in most of the systems in Argentina is only partially financed with the resources obtained through the tariff over water use or the irrigation canon. Canon values are generally quite low if they are compared with the real necessities of resources to operate the irrigation systems, maintain the works, train employees and make inversions to enlarge irrigation systems and to improve the irrigation technology (Fiorentino, 2005).

On the other hand, the compliance in the payment for the use of water is generally low, mostly in the less developed systems. As an example, some irrigation systems –located in the centre and North of Jujuy Province– have producers' associations with payment's compliance levels between 4% and 30% and in spite of that, there is still no suspension due to lack of compliance. The problems caused by lack of payment are solved with public resources not generated by the irrigation service (Fiorentino, 2005).

Water pricing is still being discussed in Bolivia. The water law proposal elaborated by the Government included the recognition of economic value of water and dispositions related to the necessity of having a patent for the right of water use, which is not considered a tax. The law proposal pointed out that the tariff would be established relating volume units and time units and would be mandatory for the concessionaires (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002). Meanwhile, the *Ley de Promoción y Apoyo al Sector Riego,* (Promotion and Support to the Irrigation Sector Law), promulgated in October 2004, establishes two ways in the use of water resources for irrigation: registries and authorisations. In the case of registries, the right to use irrigation sources is recognised and granted to native and rural communities, rural associations, organisations and syndicates, judicially guaranteeing the water resources in a permanent way, according their own customs and usages. In the case of authorisations, the right to use is given to juridical and individual persons who are not considered as register'subjects. The law does not mention a tariff payment for the right of use.

In Brazil, the ANA grants the right of use for water resources in water bodies of federal dominion, that are lakes, rivers and any water body located in federal domain, or shared by more than one State, or serve as international boundary, or run or come from others countries, according to the Federal Constitution of 1988. Waters retained in reservoirs built by the Federal Government are also considered a water body of federal domain (Praciano Minervino, 2002).

The use of water resources will be done on a participative, decentralised and integrated ground, according to the Water Resources Plan of each water basin. Therefore, each Water Basin Committee must define the collection values, according to the unitary prices and the maximum and minimum limit values. In turn, the limit values will be established by the President of the country, in the case of federal water bodies, or by the state government, in the case of state waters (Praciano Minervino, 2002).

In Paraguay, the conception of water as a free good greatly affects the valuation of water as an economical and essential resource in each production process. Pricing systems do not manage to incorporate either external factors or social costs generated in the agriculture production. Only natural goods –that is, raw materials– subject to trading transactions are computed (Gamarra Lovera, 2002).

Studies on the economic value of water have not been made in Uruguay. In fact, the application of economic instruments in the management of natural resources is practically inexistent. Although setting of prices is generally accepted as an appropriate instrument to improve water management, the issue is not free of controversy. In this respect, although the Water Code confirms the possibility of establishing a canon for public waters' use, there are neither definitions about this canon, nor specific elements to determine who and in which terms should pay. Additionally, a strategy for setting of prices is inexistent and, therefore, the use of country domain's waters remains free. There are neither a formal market of waters, since the State has not regulated the transactions and their contents and only demands the compliance of some procedural requisites, such as authorisation's request and inscription's regularisation (von Cappeln *et al.*, 2001).

The 1997 Irrigation Act has neither advanced in setting of prices, although it has set guides for public waters' use. The Act also foresees that the users of State's hydraulic works will have to pay a price set by the Executive Power (or Departmental Governments, in case of departmental works) according to the exploitation, conservation and administration expenses. Beyond the existence of this Act, the increases in water use for irrigation caused that agricultural entrepreneurs had to accumulate waters to be used during low waters, through the construction of catchments and storage reservoir works. Some enterprises have been formed to distribute water among the producers who contract their services in exchange for a price. These enterprises must get official authorisation and a water supply contract in writing; in case that they do not comply these requisites, contracts will consider null and fines foreseen by Law will be applied (von Cappeln *et al.*, 2001).

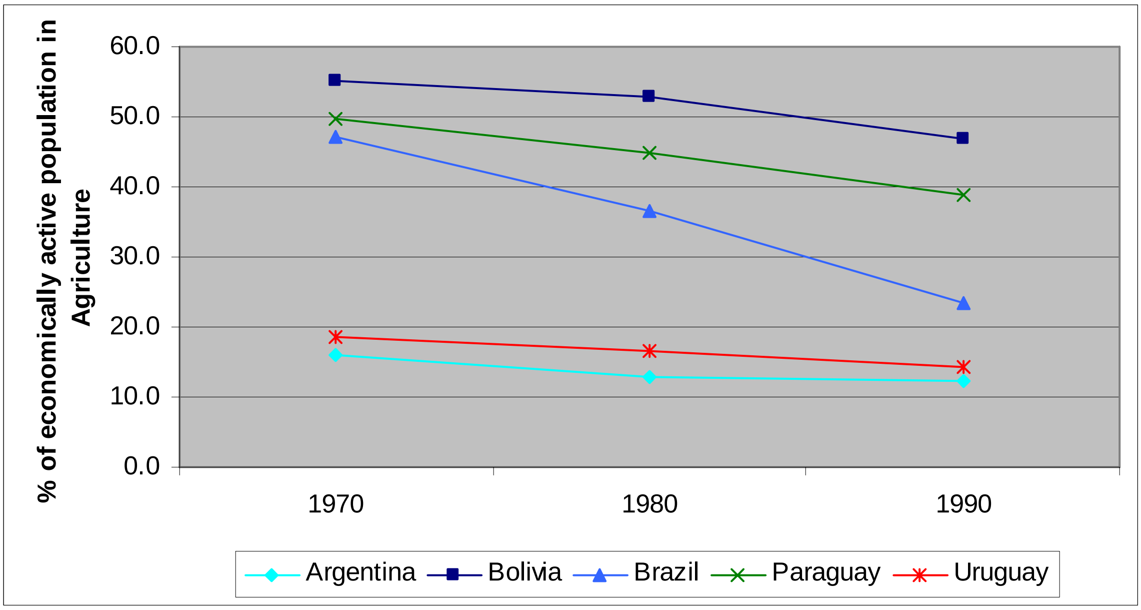
8.4.4. Social aspects of agriculture and irrigation

In this item, social aspects related with agriculture and irrigation have to do with the role of women and men in agriculture and the role of irrigation in alleviating poverty, mainly in those countries where agriculture and livestock is the most dynamic area of the economy, such as Bolivia and Paraguay. Figure 8.10 shows the percentage of economically active population in agriculture, as a way to describe the role of this activity in each country along three decades (1970, 1980 and 1990). This percentage has been declining since the 1970s, even though the participation of this kind of workers in the total economically active population is still high in both Bolivia and Paraguay.

On the other hand, the proportion of economically active men and women working in the agriculture and livestock sector would give an outlook of participation of both genders in those activities (Figure 8.11). At the beginning of 2000s, the percentage of women working in agriculture and livestock activities were less than the percentage of men, except in Bolivia and Brazil. This general tendency would be maintained by 2010; both Bolivia and Brazil would expect a slightly increase of men's participation.

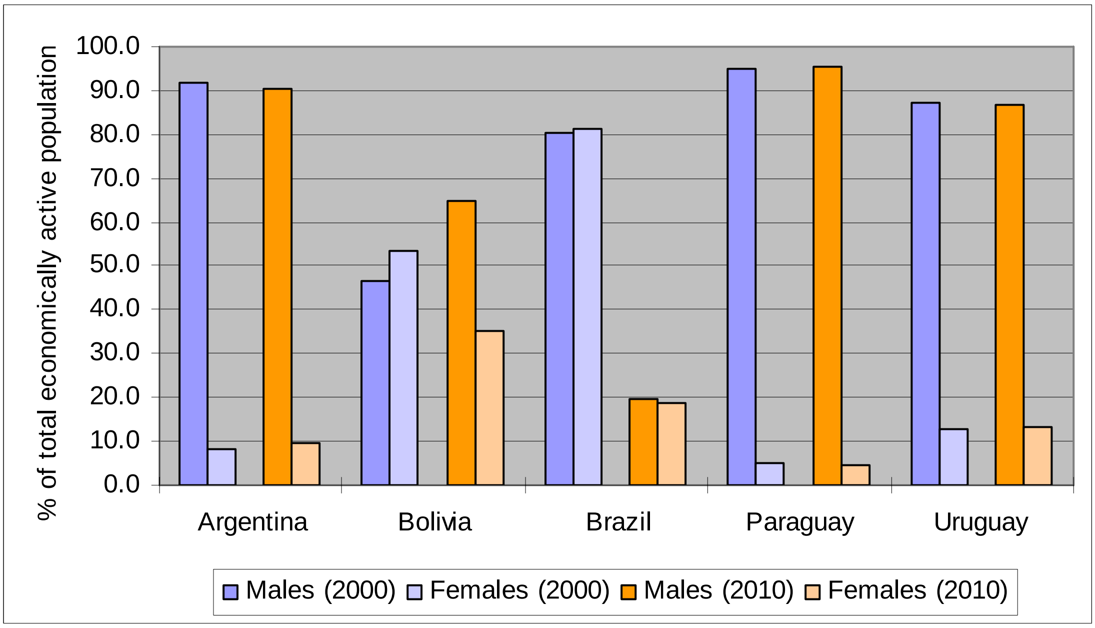
Generally, women act as partners in agriculture, assuming roles as farmers, on their own in some cases, or as partners in the work of family farms, performing essential household production tasks, as well as tending gardens, livestock, and assisting in the fields as needed. Women often help to support family farm operations or their households through paid farm work for others, or through off-farm and non-farm businesses or paid employments (Effland & Gold, 1998).

Figure 8.10. La Plata River Basin. Percentage of economically active population in agriculture



Source: CEPAL, 2004

Figure 8.11. La Plata River Basin. Economically active population in agriculture by gender and country



Source: FAO, 2004

On the other hand, the report highlighted the existence of significant water resources in several fluvial basins, lagoons and lakes. However, only 1% of this potential offer is consumed; therefore the main water deficit is related to the lack of physical infrastructure to allow their channelling and use (Gobierno de la República de Bolivia, 2001).

The agricultural activity in Paraguay seeks for maximisation in its contribution to the economic global development, as a short and middle-term goal; thus, a significant increase in rural well-being is also expected as a consequence of this maximisation (FAO, 2000 d).

Other important goal is the improvement of rural population's capacity –including the native communities– of generating income, reducing therefore the incidence of rural poverty. An increase and diversification of production and exports are needed to reach this goal, as well as the adoption of sustainable production systems, maintaining the productive and natural resources and also including the remaining natural forests. In this context, irrigation would help to increase crops' intensification and diversification (FAO, 2000 d).

Challenge: water and industry

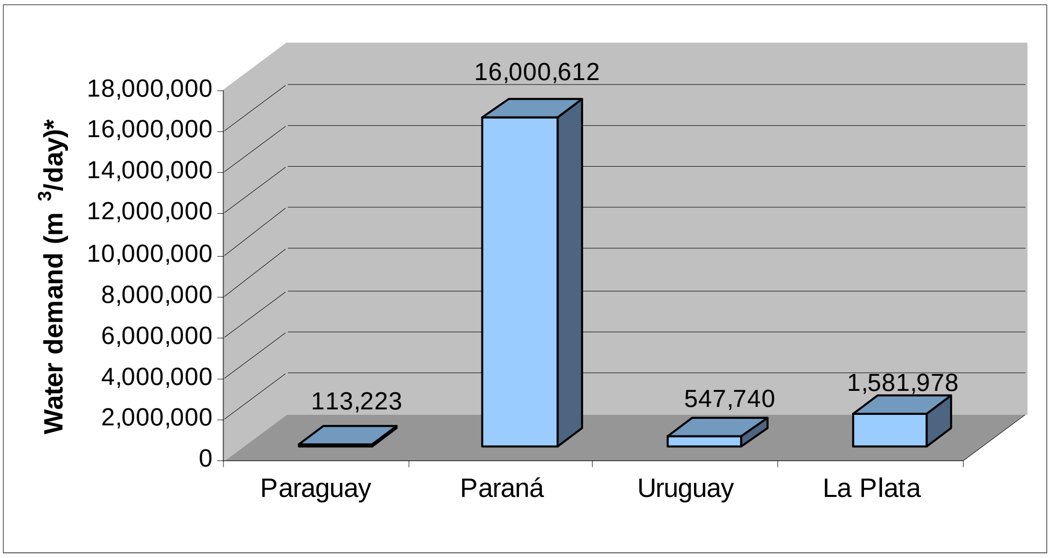
<u>Overview</u>: Industries are vital to human societies and is one of the main users of water. However, industry should assume their responsibility to respect water quality and should take account of the needs of competing sectors.

9. Water and industry in the La Plata Basin

9.1. Industrial water: demand and use efficiency

Water demand for the industry varies among the four main river systems, being the percentages over total demand of water related to the location of the major industrial areas of the basin. Figures 9.1 and 9.2 show both the total industrial water demand and the percentages over the total demand by basin (Paraguay, Paraná, Uruguay and La Plata rivers), respectively.

Figure 9.1 La Plata River Basin. Industrial water demand classified by river systems (last registered data)

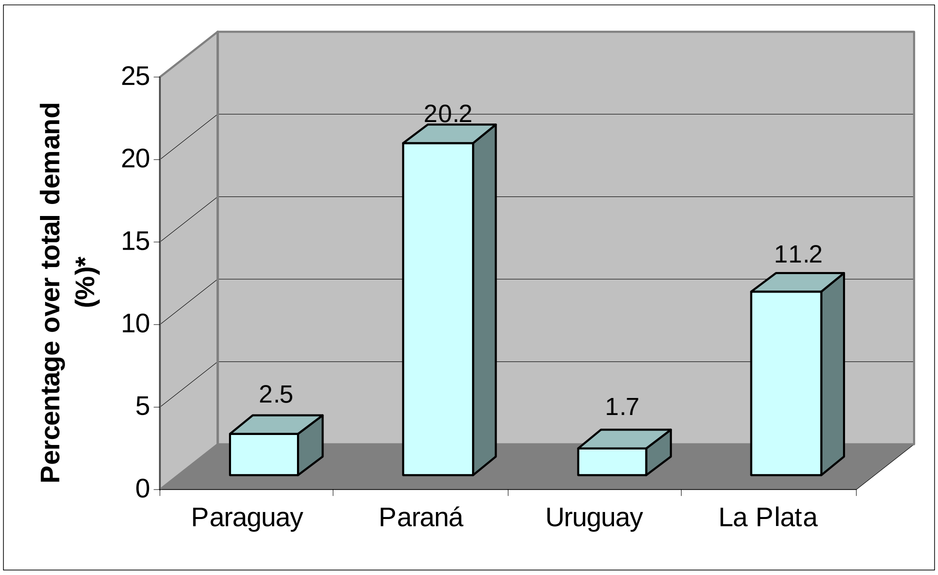


* Last registered data: Argentina, 1997; Bolivia, 2001; Brazil, 2000; Uruguay, 2004.
Source: Mugetti, 2004; Dias Coelho, 2004; Genta *et al*,, 2004; Crespo Milliet, 2004.

As it is shown in the figures, the major industrial water demand corresponds to the Paraná River System, where the biggest development of the basin in relation to this sector is concentrated. In Brazil, for example, the industrial demand of the Paraná Basin accounts for 25% of the total demand. The major concentrations are located in the Tietê River Basin (68.5%), especially in the São Paulo Metropolitan Region (Dias Coelho, 2004).

The industrial demand of the La Plata River corresponds mostly to the Argentine riverbank, which with its 1,544,898 m^3/day, accounts for 97.6% of the total (Mugetti, 2004; Genta *et al.*, 2004). The La Plata River is also, in Argentina, the system upon which the greatest industrial consumption pressure is exerted, represented above all by the different industries located in the Buenos Aires Metropolitan Area. It is followed in importance by the Paraná River System with 386,212 m^3/day (Mugetti, 2004).

Figure 9.2. La Plata River Basin. Percentage of industrial demand over total demand of water



* Last registered data: Argentina, 1997; Bolivia, 2001; Brazil, 2000; Uruguay, 2004.
Source: Mugetti, 2004; Dias Coelho, 2004; Genta *et al*,, 2004; Crespo Milliet, 2004.

In the case of the Uruguay River Basin, the major concentration is located in the Brazilian sector (Upper Uruguay) where agro-industrial, wood and cellulose production industries are found (Dias Coelho, 2004). Argentina and Uruguay have a small share of the total water demand (Mugetti, 2004; Genta *et al.*, 2004).

Even though data on water industrial demand has not been found for Paraguay, it is known that the industry ranks water use as the lowest priority (Monte Domecq, 2004). In any case, the major concerns of the country are much more focused on the resource quality and management than on quantity and availability.

Regarding the industrial water use efficiency, the case of Brazil should be highlighted, through the actions taken by the *Câmara Técnica de Ciência e Tecnología*, CTCT (Technical Chamber of Science and Technology) (See Box 9.1).

9.2. Impact of industry on water quality degradation

The main characteristics related to industrial environmental impact are (Fernández Busto, 2001):

- *Location:* Industrial facilities –particularly small and medium-sized enterprises, SMEs– are installed in areas that are not prepared for production (such as urban areas, or areas without appropriate supplies and services), and they discharge waste into municipal systems.

- *Technology:* Except for large companies, most do not have profitable technologies in place, and show excessive water consumption.

Box 9.1. Water use efficiency in industry: the case of Brazil

The *Câmara Técnica de Ciência e Tecnología,* CTCT (Technical Chamber of Science and Technology) within the *Conselho Nacional de Recursos Hídricos*, CNRH (National Council of Water Resources) of Brazil has some attributions related to water use efficiency in industry. One of the Chamber's attributions is the proposal of actions, studies and research in the water resources field so as to obtain improvement in technologies, equipment and methods concerning their use and exploitation. It is also entitled to analyse water-related issues and express its opinion about them.

Figure 9.3. Water reutilisation in Brazilian industries

Source: http://www.fiesc.org.br

The Chamber has many working groups, two of which are linked to the efficiency of water use in the industry. Group 1 works with the reutilisation of non-drinking water (Figure 9.3) and Group 3 works with the efficient water use in urban and industrial processes. Both Groups have periodical meetings and discuss technical tools and legal mechanisms to achieve the Chamber's goals. For example, Group 1 has defined several criteria and variables for the re-use of waters, taking into account different activities. Meanwhile, Group 3 has established a set of actions to take in the future, in order to reach an efficient use of water; for example, one of the proposed actions has to do with the use of the *Marca Brasil* (Brazil Trade Mark) in products obtained through social and ecologically sustainable processes, such as the rationale use of water and natural resources.

- *Environmental Licences:* Most SMEs are not environmentally licensed, usually because of lack of information concerning environmental standards.

- *Control:* Emissions, effluents and solid waste. This control is reduced to application in large companies primarily, and is applied in a very limited way to SMEs due to lack of technical, human and financial resources.

- *Economic incentives:* Very limited and hard to access; there is also a lack of information concerning them.

The industries showing the greatest impact on the environment are: the extractive industries (mining and oil), mining-metallurgy, petrochemical and chemical industries, and, in some cases, cement and lime. In general, these industries cause leakage and drainage of hazardous waste that is highly dangerous to the environment, in addition to the discharge of residual waters into receiving water bodies. On the other side, atmospheric emissions are particularly important in foundry and refinery processes (Fernández Busto, 2001).

In the next paragraphs, the water pollution situation is described as a result of the industrial activity in the four major subsystems of the basin.

9.2.1. Paraná River

In the Paraná River, pollution problems are not generalised due to its huge depurating capacity. Nevertheless, there are isolated cases of industrial pollution in different sectors of the basin, both in the Paraná River itself and in its tributaries.

In Brazil, the existence of major urban centres in the Paraná River Basin, like São Paulo, Brasilia, Curitiba and Campinas, exerts pressure on water resources as a result of the increase in demand, the rise in the pollution load and the effects of urban drainage, as well as the occupation of springs and floodplains (Dias Coelho, 2004).

There is a high industrial concentration in São Paulo Metropolitan Area, in the Piracicaba River Basin, and in Curitiba Metropolitan Area –at the Upper Iguaçu River–. The treatment of industrial discharges is higher than of domestic ones, but yet the remaining discharges jeopardize the regional rivers, mainly because the major industrial concentrations are also situated in the basins' headwaters, like the Upper Tietê in São Paulo and the Upper Iguaçu in Curitiba (Dias Coelho, 2004).

Regarding the dumping of polluting industrial discharges, two types of industries related to the agriculture and livestock sector stand out: sugar-alcohol and poultry and pork industries. The former increased with the alcohol incentive programme, diminishing its influence over the last years, but it still has relevant importance in the impacts on the river waters, mainly in São Paulo State. The food industry, which had its major production in western Santa Catarina State, has expanded towards Paraná, Mato Grosso do Sul and Goiás states. Within this process of productivity increase, production was outsourced in the rural area, which resulted in the discharge of diffuse loads, even though its effect concentrates in some river stretches in terms of the totality of its impacts.

In the Lower Paraná Basin, there are serious pollution problems in the industrial area around the Rosario-Buenos Aires corridor –the so called La Plata River fluvial front–, with high fish mortality rates and other acute events of negative impact on biodiversity. Close to Rosario City, algae concentration, between 15,000 and 300,000 ind/l, and turbidity, which is of 30-230 NTU, has an impact on water use for human consumption. On the other hand, the tanneries in Esperanza City (Santa Fe Province) discharge their residual waters in the water bodies of the northern Salado River Basin(Mugetti, 2004).

9.2.2. Paraguay River

In the Brazilian sector of the Upper Paraguay Basin, water resources are polluted as a result of mining activities, mainly in Mato Grosso State, and the pesticides used in annual crops in the Planalto –Plateau– Region (Dias Coelho, 2004). In Paraguay, the major sediment loads come from the agricultural activity (tilling and pasturing); only in the areas close to large urban centres like Concepción, Asunción and Pilar (Lower Paraguay Basin), industrial and domestic effluent discharges are observed (Monte Domecq, 2004).

As regards Paraguay River's two main tributaries (Bermejo and Pilcomayo rivers), a certain degree of pollution caused by oil waste was detected in the Bermejo River Basin. It seemed to come from oil exploration wells that discharged waters used in exploitation to different tributaries of the basin, with high salinity (above 120 g/l), high temperature (about 80º C) and hydrocarbon traces (Mugetti, 2004).

In the Pilcomayo River, which has a predominance of detritivorous fish species, a particularly relevant content of heavy metals has been detected. In Misión La Paz (Salta Province, Argentina) high concentrations of lead, arsenic, copper, mercury, zinc and silver have been found (Mugetti, 2004).

Worthy of special mention is the mining activity in the Bolivian Upper Paraguay Basin. There are tin deposits in the form of cassiterite or in the form of tin sulphide minerals, related to other metals; the discharges of waters used in extraction and processing, as well as the erosion and dissolution of mine wastes, contaminate rivers and groundwater. Information on affected groundwater flow is preliminary; information on polluting emissions towards surface waters as a result of shaft-mining and acid drainage of open-pit mining activities is not precise. Acid drainage was estimated in some 4,000,000 m^3, related to a total solids load of 643,000 t, of which about 522 t are suspended solids (Crespo Milliet, 2004).

9.2.3. Uruguay River

In the Upper Uruguay Basin, the major sources of industrial pollution are located in the tributaries Peixe and Canoas rivers. Peixe River has a specific diffuse load production due to the industrial activity of Santa Catarina State. The effluents originate in paper, leather and food industries; the cities of Caçador, Videira (in Peixe River Basin) and Lages (Canoas River Basin) are the main centres. These loads have increased due to the rise in production, the outsourcing of industrial production and the difficulty in treatment of small loads, which brings about a diffuse load production for the basin. Most of the urban-domestic effluents are discharged without any treatment into the fluvial systems, thus creating inadequate conditions in most of the urban rivers that drain within the cities (Dias Coelho, 2004).

9.2.4. La Plata River

In the La Plata River, the major industrial pollution originates in the main discharges into the system from the area of the major urban conglomerate in Argentina with the largest number of industries, particularly between the Riachuelo River and Berazategui Municipality (Buenos Aires Province). The heavy metals and the persistent organic pollutants (POPs) are the main sources for the creation of impacts from inadequately controlled urban sources. Thus, chromium and lead present maximum concentrations above the limits established by reference levels, diminishing their concentration transversally to the coast. Nevertheless, given the association of heavy metals with suspended material, a correct characterisation of the critical areas must take into account a probable increase in the concentration of metals associated with an increase in suspended loads, and not as a result of an increase of metals in solution (Mugetti, 2004).

Persistent organic pollutants (POPs) are widely distributed, concentrating in sediments and biota. In spite of its huge dimensions, the coastal ecosystem of the La Plata River is affected by POPs, which are concentrated in organic sediments and in detritivorous organisms such as "sábalo" (*Prochilodus lineatus*), which is a fish with high fat level and an efficient accumulator of POPs (Mugetti, 2004).

The distribution of chlorinated pesticides and polychlorinated biphenyls characterises both the riverbank and the discharges into the system, and it allows differentiating agricultural pollution from the industrial one (with preponderance of PCBs). The impact area would not be very wide if the reduction in pesticide concentrations in terms of the distance to the Argentine riverbank is taken into account. For PCBs, however, concentration does not vary significantly, probably due to their resistance to degradation. PCB levels detected in "sábalo" are higher to those recommended for human consumption in the riverbanks of Berazategui, Quilmes, Hudson and Punta Lara (Buenos Aires Province) (Mugetti, 2004).

A study carried out by the *Dirección de Prevención y Gestión de la Contaminación,* DPGC (Directorate of Pollution Prevention and Management) under the *Secretaría de Ambiente y Desarrollo Sustentable,* SAyDS (Secretariat of Environment and Sustainable Development), selected 859 potentially heavy metal generating facilities as study cases since these residues are of high attention priority due to their impact on the environment and human health derived from bioaccumulation and toxicity phenomena. According to the typical pollutants of the productive process, two sub-groups are defined, besides heavy metals. The Group A include Sulphides, Cyanide Salts, acids and bases, and the Group B include Phenols, Solvents, SSEE[48], SRAO[49] and solids. Table 9.1 shows the results of the study (DPGC, 2005).

Table 9.1. Buenos Aires Metropolitan Area. Types of industrial facilities and discharge volume.

Activities	Group	Quantity	Discharge Volume
Tanneries (sulphides)	A	50	90% in Buenos Aires Province, with a volume of up to 6,000 m^3/day
Galvanoplasty (cianyde Salts)	A	208	60% in Buenos Aires City with < 20 m^3/day volume
Acids, bases	A	6	Volumes of about 100 m^3/day
Chemical pharmaceutical products	A	113	Up to 540 m^3/day
Fungicides, insecticides, disinfectants	B	4	200 m^3/day
Paints (phenols, solvents)	B	32	85% in Buenos Aires Province with a volume of up to 480 m^3/day
Inks and bitumens (phenols, solvents)	B	9	< 15 m^3/day volume
Matches, candles (SSEE)	B	4	< 35 m^3/day volume
Synthetic resins factories (SSEE)	B	13	below 80 m^3/day
Soaps and detergents (SRAO)	B	36	900 m^3/day volume
Iron, steel and nonferrous production (solids)	B	69	Iron & steel above 200 m^3/day nonferrous below 10 m^3/day
Rubber and tire production	B	68	Tire Production > 200 m^3/day
Paper-related (Solids)	B	59	Volumes above 500 m^3/day
Metallic carpentry, springs, tin plate products, nails, pins, drums (Solids)	B	187	Volumes below 40 m^3/day
Cigarette manufacturing (Solids)	B	1	180 m^3/day into Medrano Stream

Source: DPGC, 2005

[48] SSEE: Substances Soluble in Ethyl Ether.
[49] SRAO: Determination of detergents by orto-toludine method.

The facilities discharging into the sewerage system are located in Buenos Aires City, and the first stretch of Buenos Aires Metropolitan Area. From the samples studied, a serious lack of treatment of the discharges directed to the watercourse can be observed in the facilities, while there is a greater amount of treatment systems in those discharging residues into the sewerage system (DPGC, 2005).

At the La Plata River mouth (Samborombón Bay), the bioaccumulation of POPs in the biota was analysed, both of organochlorinated pesticides and PCBs. This presence is indicative of water column and sediment pollution. POPs enter the Samborombon Bay from an area devoted to industrial and agricultural activities. These compounds are spread in the river through water flows and winds, and eventually incorporated into sediments and accumulated in the fatty tissues of the biota (Mugetti, 2004).

In the case of Uruguay, the La Plata River system presents the most relevant pollution in the country and it affects most of the urban watercourses: Carrasco, Miguelete, Pantanoso, Colorado and Las Piedras streams and many of their tributaries. Pando Stream, which could be included in the list, presents qualitatively lower pollution levels than the previously mentioned ones (Genta *et al.*, 2004).

They are low-volume watercourses of highly urbanised very small basins. These watercourses present a practically permanent deoxygenation in most of their stretches and a high presence of solid waste in their banks. This deoxygenation is caused by anaerobiosis situations and consequently, it is a source of permanent unpleasant odour, which generates environmentally degraded areas (Genta *et al.*, 2004).

Three pollution sources have been identified in Uruguay: urban domestic sewage discharges from the sewerage system, industrial effluent discharges and urban solid waste dumping. The first two (sewage liquids and industrial discharges) are decreasing due to the extension of sewerage systems and the control of industrial effluents. The presence of trash in the channels and banks of urban watercourses has increased throughout time. The systematic trash dumping into watercourses has two identified origins: low acceptance of the waste collection system and the use of watercourses for reception of non-recycled trash discard by classifiers (Genta *et al.*, 2004).

9.3. Policy guidelines and incentives

Information on existing programs and projects related mostly to the implementation of clean production mechanisms in the industry has been identified in the five countries of the La Plata Basin and presented below.

9.3.1. Argentina

The SAyDS is the environmental authority at the federal level, whose role is that of monitoring and controlling industrial pollution. The following policies linked to the promotion of clean production in the industry are developed within this agency:

- *Política Nacional en Producción Limpia y Consumo Sustentable* (National Policy on Clean Production and Sustainable Consumption)*:* its formulation is the result of a broad consultation and interaction process with representatives of organisations from the public, private, academic, scientific and civil society sectors, coordinated by the *Unidad de*

Producción Limpia y Consumo Sustentable, UPLCS (Clean Production and Sustainable Consumption Unit) of SAyDS. This Policy aims at favouring the competitiveness of companies, improving their environmental performance. In this sense, the UPLCS promotes and strengthens the actions proposed within this Policy framework, based on the communication and cooperation with all the involved agencies (SAyDS, 2004).

- *Programa de Producción Limpia y Competitividad Empresarial* (Clean Production and Corporate Competitiveness Programme): This Programme is in line with the National Policy carried out by the UPCLS, and has the objective of implementing programmes in different industries so as to improve productive efficiency, environmental performance and as a result, their competitiveness. At the La Plata Basin level, the programme started in Avellaneda Municipality (Buenos Aires Province) can be mentioned, in which the Municipality and the local Industrial Association jointly participate, and it is firstly oriented to the metallurgic, food and graphic sectors. The other case in the La Plata Basin is that of Jujuy Province, where the companies and the provincial environmental authority have agreed upon the need to adopt a clean production programme. This case includes about 9 companies from different sectors, among which the food (sugar), mining, paper and metallurgic ones stand out (Beláustegui, 2004).

- *Programa Nacional para la Promoción de la Producción y el Consumo Sustentables* (National Programme for the Promotion of Sustainable Production and Consumption): implemented by the *Dirección de Ordenamiento Ambiental*, DOA (Directorate of Environmental Planning) of the SAyDS, whose objective is promoting the adoption of environmental technologies, processes and services and sustainable consumption habits. The programme aims to initiate the promotion and adoption of environmental technologies, processes and services through the use of adequate tools and technical assistance to develop the beneficiaries' skills to join the programme. As a strategy, the programme will promote actions on awareness and situation diagnoses in order to increase the beneficiaries' capacity to adopt environmental technologies, processes and services; it will also promote the gradual incorporation of potential beneficiaries into the programme. Based on the situation diagnoses, proposals will be made in terms of surveyed needs; mechanisms for the assessment and performance of environmental technologies, processes and services will be also developed, thus generating pilot projects, whose experiences will be useful for the adjustment and consolidation of suitable tools towards the sustainable production and consumption (Dirección de Ordenamiento Ambiental de la Argentina, 2004).

On the other hand, the *Subsecretaría de Industria de la Nación* (National Undersecretariat of Industry), the national authority in this field, has an Environmental Unit that develops programmes related to productive processes and the environment, such as the *Programa de Análisis de Procesos Productivos Contaminantes* (Polluting Productive Processes Analysis Programme), which consists in analysing each stage of the processes and the products of various of the most polluting industrial sectors, so as to determine their environmental incidence. The proposed methodology consists in gathering the general information on the polluting action each process has, and later on, visiting some plants to reconcile the gathered information with the national reality. Another programme that is being implemented is the *Etiquetado Ecológico* (Ecological Labelling), which not only has an environmental aim in itself but also the objective of providing information to the consumer.

9.3.2. Bolivia

The following policies and incentives have been identified in Bolivia:

- *Fondo para la Producción más Limpia (Fund for a Cleaner Production):* It was established through the financial contribution of the World Bank and the *Fundación para la Producción*, FUNDA-PRO (Foundation for Production), in an agreement signed in September 2000. At first, this Fund financed energy projects of biomass rational use in small and micro rural companies. In 2005, it has been extended to Cleaner Production projects, that is to say, pollution prevention and energy efficiency projects in industrial, commercial and service, urban and rural companies. Its mission is generating an economic and financial tool for the Bolivian business sector, especially for small and medium-sized companies, which allow implementing pollution prevention and energy efficiency practices.

- *Premio Nacional a la Eco-eficiencia (National Eco-efficiency Award):* This award is granted due to the initiative and efforts of the *Cámara Nacional de Industrias*, CNI (National Chamber of Industries), with the support of the *Centro de Promoción de Tecnologías Sostenibles*, CPTS (Sustainable Technologies Promotion Centre) and the Programme of Danish Cooperation to the Environmental Sector. It is an incentive intended to promote the implementation of measures that provide evidence of the companies' environmental commitment. The interested companies presented the results of their eco-efficiency projects in the following categories or theme fields (Cámara Nacional de Industrias, 2003):

    - Environmental Pollution Prevention;
    - Energetic Efficiency; and
    - Improvement in Environmental Behaviour.

  The award recognizes the commendable work performed by industrial companies and their contribution to the protection and conservation of the country's environmental conditions towards sustainable development (Cámara Nacional de Industrias, 2003).

9.3.3. Brazil

In general, it can be said that the "environmental value" is not yet a requirement to conquer and sustain markets in Brazil. Nevertheless, a growing level of investments to comply with the environmental legislation has been observed, mainly in those industries that export their products. Thus, some Brazilian industrial sectors have been required to prove that the pollution levels in their plants are compatible with the requirements of the countries they export to. In other cases, the ISO 14,001 certification is not enough, making it necessary to provide the importer with a copy of the semester maintenance report signed by an independent auditor (Kakuta, 1999).

Regarding the implementation of clean production mechanisms, the *Centro Nacional de Tecnologias Limpas*, CNTL (National Clean Technologies Centre), is the national authority that intends to promote this kind of practices in the entire country. The CNTL was created in 1995 with UNDP assistance (Mattos de Lemos & Castro, 2002). Its work has allowed generating cleaner production nuclei in the whole country. In the La Plata Basin, the following states have already installed cleaner production nuclei:

- *Rio Grande do Sul:* it was the first cleaner production nucleus established in the country in 1996. The *Programa de Demonstração em Plantas Industrais* (Demonstration Programme in Industrial Plants) was started in that same year with the training of producers and the introduction of the cleaner production methodology in eleven small and medium-sized companies (five agroindustrial, four metal-mechanic and two chemical) The good results obtained facilitated the programme expansion to other industries of the state and its neighbouring states (Mattos de Lemos & Castro, 2002).

- *São Paulo*: it is established in the Regional Department of the *Serviço Nacional de Aprendizagem Industrial*, SENAI (National Industrial Learning Service) in São Paulo. Inaugurated in 2000, it is currently implementing the P+L methodology in three schools of the SENAI: Graphic Arts, Civil and Textile Construction. Due to the current demand, the Centre is working with four companies to install Environmental Management Systems for their later certification. In these cases, cleaner production is a tool for the environmental management system (Mattos de Lemos & Castro, 2002).

- Besides the SENAI Cleaner Production Centre, there is also the *Departamento de Desenvolvimento e Capacitação Tecnológica* (Technological Training and Development Department), established within the *Companhia Estadual de Tecnologia de Saneamento Ambiental*, CETESB (State Environmental Sanitation Technology Company). Two pilot projects have been finished, whose financial achievements were the incentive of other companies and their associations to continue the implementation of cleaner technologies on their own. In Limeira City, CETESB is going to initiate the second phase of the project, which involves small companies; due to the large number of companies involved, it has been planned to start a programme to monitor the rivers of the region aiming to the better assessment of the environmental improvements obtained. As an example of the programme's results, the textile sector achieved a 25% reduction in water consumption (Mattos de Lemos & Castro, 2002).

- *Mato Grosso*: the cleaner production centre was established in 2000, in Cuiabá City, within the *Federação de Indústrias do Estado do Mato Grosso,* FIEMT (Mato Grosso State Industries Federation). It specialises in a cleaner production in the forestry sector (Mattos de Lemos & Castro, 2002).

- *Santa Catarina*: the cleaner production centre was established in 2000 in Florianópolis City, within the *Federação de Indústrias do Estado de Santa Catarina*, FIESC (Santa Catarina State Industries Federation). It groups different branches of the industry like metal mechanic, textile, meat processing, agroindustrial, and automobile (Mattos de Lemos & Castro, 2002).

- *Minas Gerais*: the cleaner production centre was established in Belo Horizonte, within the *Federação de Indústrias do Estado do Minas Gerais*, FIEMG (Minas Gerais State Industries Federation). It offers services like environmental education, the implementation of ISO 14,001 environmental management systems, cleaner production and environmental licensing (Mattos de Lemos & Castro, 2002).

On the other hand, the *Ministerio de Medio Ambiente*, MMA (Ministry of Environment), which is the national environmental authority, implements the *Programa Brasileiro de*

Rotulagem Ambiental (Brazilian Programme on Environmental Labelling), which includes as one of its objectives promoting the environmentally sustainable innovation within the industry in order to provide the Brazilian industry with a more efficient insertion into the international market (Ministerio do Meio Ambiente da República Federativa do Brasil, 2005).

9.3.4. Paraguay

According to the assessment of the *Ministerio de Industria y Comercio*, MIC (Ministry of Industry and Trade), the factors that affect the Paraguayan industries in connection with the environmental issue are five (Servín, 2004):

- *Legal:* The environmental legislation of the country does not take into account the possibility of a gradual adjustment to the minimum standards required by the Sanitary Code (Resolution 585/95).
- *Sectorial:* The industrial sectors with the most negative impacts on the environment are: tanneries, meat processing plants and slaughterhouses, among others, which in most cases do not have treatment systems that allow them to comply with the legislation.
- *Institutional*: National, departmental and municipal authorities, in charge of promoting and developing environmental awareness in industrial companies, have institutional weaknesses.
- *Technological*: The technologies acquired for the industrial process constitute a relevant factor to determine the environmental impacts that a company might generate.
- *Financial:* The requirements to adjust the legal framework in force establish the need to perform investments that might need financing. This will need to have a suitable financial architecture.

The MIC, through its *Dirección Técnica Ambiental* (Environmental Technical Directorate), implements the following policies:

- *Plan de Adecuación Ambiental para las Industrias (Plan of Environmental Adjustment for Industries):* it was created taking into account that economic development and environmental protection are totally compatible and, from this perspective, equivalent. With this thought, the MIC seeks to match industrial economic interests with environmental protection, using a new concept of Cleaner Production, which is a pollution-preventive system. It consists in implementing changes and improvements in the productive processes, in the use of resources and raw materials and in industrial waste treatment systems. It has three components: technical, financial and legal assistance (Servín, 2004).

  This plan is a part of the environmental component of the MIC, which works as an interphase between the National Industrial Policy and the National Environmental Policy. One of its main purposes is the introduction of the environmental dimension into the productive sectors, as a long-term challenge, with the objective of minimising the impacts and risks to human beings and the environment, guaranteeing environmental protection, economic growth, social welfare and corporate competitiveness (Servín, 2004).

- *Programa de Producción más Limpia para Micro, Pequeñas y Medianas Empresas de Paraguay (Cleaner Production Programme for Micro, Small and Medium-sized Paraguayan Companies):* the Adjustment Plan was one of the precedents used for the implementation of this Plan. The *Dirección Técnica Ambiental* participates in this programme together with the German Agency GTZ (Competitiveness and Environment Project), the Paraguayan *Secretaría del Ambiente*, SEAM (Secretariat of Environment) and the IDB. The programme's objective is to increase the competitiveness of micro, small and medium-sized companies through the environmental performance, using cleaner production processes and prioritizing prevention rather than remediation of environmental conflicts. This objective is achieved through the implementation of the *Gestión Ambiental Rentable,* GAR (Profitable Environmental Management), which facilitates the reduction in production cost, the improvement in environmental impacts and the optimisation of administrative structures in companies that voluntarily join the programme (Dirección Técnica Ambiental del Paraguay, 2004).

On the other hand, the SEAM –national environmental authority–, through the *Dirección General de Gestión Ambiental* (General Directorate of Environmental Management), is in charge of establishing procedures for the authorisation of effective or potentially environment-polluting activities. In addition, it can promote environmental management systems, especially those aimed at productive development activities, prepare technical aptitude reports and promote the recognition of the ecocycles of products and processes (Dirección General de Gestión Ambiental del Paraguay, 2004).

The SEAM is also in charge of the *Programa de Implementación de Medidas Ambientales* (Programme on Environmental Measures Implementation), which immediate precedent is the *Plan de Adecuación Ambiental* (Environmental Adjustment Plan). This Programme establishes specifications to comply with the standards of Resolution 585/95 on Resources Quality Control, among other things. Thus, it incorporates cleaner production techniques in the preventive phase, through minimisation of wastes, improvements in operation processes, implementation of corrective measures, use of substitute materials, recycling, etc. It also establishes gradual maximum terms (3, 4 and 6 years) to reduce polluting discharges according to the size, location, and technical and financial aid availability of the industries (Servín, 2004).

9.3.5. Uruguay

In Uruguay, the control of industrial effluents is under the jurisdiction of the *Dirección Nacional de Medio Ambiente*, DINAMA (National Directorate of Environment) del *Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente*, MVOTMA (Ministry of Housing, Territorial Planning and Environment), although the municipalities can develop regulations that complement the national provisions, as is the case of the Montevideo Intendancy. The DINAMA performs the industrial control under Decree 253/79, controlling the different plants with effluent treatment ponds in the country. There is an updated report of the industrial effluent situation of those companies with more than 10 employees (Barrenechea, 2002).

On the other hand, the *Comisión Técnica Asesora de la Protección del Medio Ambiente,* COTAMA (Technical Advising Commission for Environmental Protection) was created to cooperate in the national environmental plans, which is presided over by the MVOTMA and composed of other institutions, due to the interdisciplinarity and interinstitutionality of the environmental problems (Barrenechea, 2002).

Montevideo Intendancy has passed a regulation that defines different categories of industrial mud, their treatment and final disposal, according to their hazardousness. The mud problem is important in other parts of the country but there are no regulations on this issue. There is not a specific regulation at a national level regarding industrial solid waste either; only 4% of non-domestic private waste is controlled by the Environmental Hygiene Laboratory of the Intendancy (Barrenechea, 2002).

Environmental certification under ISO 14,001 standards has been in force in Uruguay since 1998. This task is responsibility of the *Instituto Uruguayo de Normas Técnicas*, UNIT (Uruguayan Institute of Technical Rules) and of the *Laboratorio Tecnológico del Uruguay*, LATU (Technological Laboratory of Uruguay) (Barrenechea, 2002).

Regarding the promotion of cleaner production, Uruguay does not have major programmes or projects in the public sector in connection with environmental management and cleaner production. There is only a relevant advance in the policies and regulations on the "end of pipe" problem, that is to say the environmental problems that companies have outwards –the environment and the community–. The following are the projects, programmes or initiatives promoting environmental management and/or ecoefficiency and cleaner production in the country:

- *Programa de Cuidado Responsable de ASIQUR (ASIQUR Responsible Care Programme):* implemented by the *Asociación de Industrias Químicas de Uruguay*, ASIQUR (Chemical Industries Association of Uruguay), of Canadian origin, which has been applying in Argentina and Brazil at the beginnings of 2000s. It consists in a programme of permanent environmental management improvement, considered in an integral way, both outside and inside the company, on the basis of the observance of labour codes (information to the community, emergency response, pollution prevention, safety in productive processes, transport and distribution, health and personnel safety and responsible product care), provided at the beginning of the programme so that companies can measure their results, record them and generate instances for the company's interaction. The adoption of the programme is voluntary and those who adopt it receive permanent support from a technician specialised in the field and with a sound knowledge of the programme. At the beginning of 2000s, the programme was being extended to companies not included in ASIQUR (Barrenechea, 2002).

- *Parque Tecnológico Industrial (Industrial Technological Park):* an initiative of the *Intendencia Municipal de Montevideo*, IMM (Municipal Intendancy of Montevideo), it is not precisely intended for promoting environmental management or cleaner production, but for providing a space for environmental companies. The initiative is an agreement between the IMM and the *Asociación Nacional de Medianas y Pequeñas Empresas,* ANMYPE (National Association of Small and Medium-Sized Companies). Companies were offered a space where synergies could be developed among companies of a certain type and they were also given old facilities (an abandoned meat processing plant) with no cost, taxes, municipal expenses, water or electric energy costs, which they only had to repair or set up. A special plan has been developed as well to provide them clean-up services so as to improve the companies' performance. The environmental legal authorisation –granted by DINAMA– was still pending at the beginnings of 2000s (Barrenechea, 2002).

- *Programa 200 PyMEs (200 Small & Medium-Sized Companies Programme):* its purpose is increasing companies' competitiveness and achieving measurable improvements in their corporate performance, facilitating the adoption of Quality Systems (ISO 9,000), Environmental Management (ISO 14,000) and Occupational Health (ISO 18,000), so as to maximise their exports. It provides technical assistance with specialised consultants, enables designing procedure manuals to improve its management with standardised systems, which allows for cost reduction and reliabilities to product demanders (Barrenechea, 2002).

- *Incubadora de Empresas de Base Tecnológica y Polo Tecnológico (Incubator of Technology Base Companies and Technology Pole)*: although they are not directly linked with cleaner production or promotion of environmental management, these undertakings could facilitate the achievement of the objectives of the project since it comprises environmental companies and technological innovations (Barrenechea, 2002).

- *Programa de Desarrollo Tecnológico (Technological Development Programme)*: It is executed under the *Dirección Nacional de Ciencia, Tecnología e Innovación,* DINACyT (National Directorate of Science, Technology and Innovation) of the *Ministerio de Educación y Cultura*, MEC (Ministry of Culture and Education) for a five-year period and with external financing (for the most part). Its general objective is to mobilise the country's resources to maximise innovation processes so as to strengthen productive competitiveness (Barrenechea, 2002).

Challenge: Water and Energy

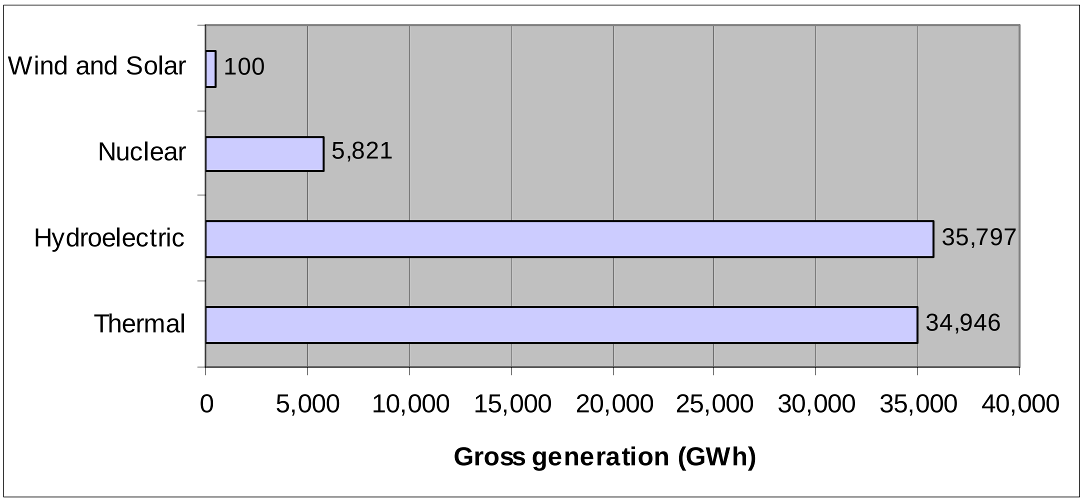
Overview: Water is vital for all forms of energy production. There is a need to ensure that energy requirements are met in a sustainable manner while minimizing the environmental impacts. The development concerns of the less-developed regions of the world need to be recognized.

10. Water and Energy in the La Plata Basin

10.1. Current energy production and needs

Examining country by country, the distribution of installed capacity in Argentina shows that thermal power currently has a big share of the market, accounting for nearly 58% of installed capacity. As regards gross generation, hydroelectric power is contributing 1% more than thermal power. Figure 10.1 shows data of energy generation in Argentina.

Figure 10.1. Argentina. Energy generation by source (2002)



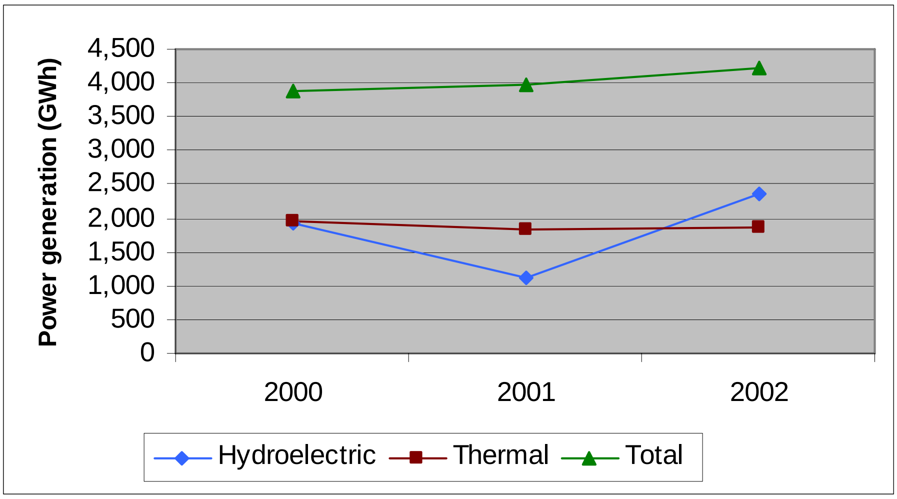
Source: Mugetti, 2004.

In Bolivia, generation data between the years 2000 and 2002 point to a gradual rise in hydroelectric power and a reduction in thermal energy, as Figure 10.2 shows.

In the case of Brazil, the participation of the La Plata Basin' states in power generation is high in most of the cases, such as oil and mineral coal production, electric generation and alcohol production. Table 10.1 shows the production obtained in 2003 in those states, compared with countrywide generation.

In Paraguay, the production of primary energy is made up exclusively of renewable energy sources (hydropower and biomass); there is no oil production. The production of natural gas is local and marginal, and for the moment does not constitute a significative contribution to the national energetic structure. Approximately 65% of the gross domestic energy supply in Paraguay is made up of hydropower (Viceministerio de Minas y Energía de la República de Paraguay, 2003).

Figure 10.2. Bolivia. Electric power generation by source (2000-2002)



Source: Crespo Milliet, 2004.

Table 10.1. Brazil. Electric power generation and production of renewable energy sources (2003)

Energy Sources		Brazil (total)	Basin States (total)
Production of	Oil (10^3 m^3)	86,819	71,314
	Natural Gas (10^6 m^3)	15,791	7,104
	Mineral Coal (10^3 t)	4,649	4,649
Electric Generation (GWh)		364,942	273,467
Alcohol Production (10^3 m^3)		14,468	12,772

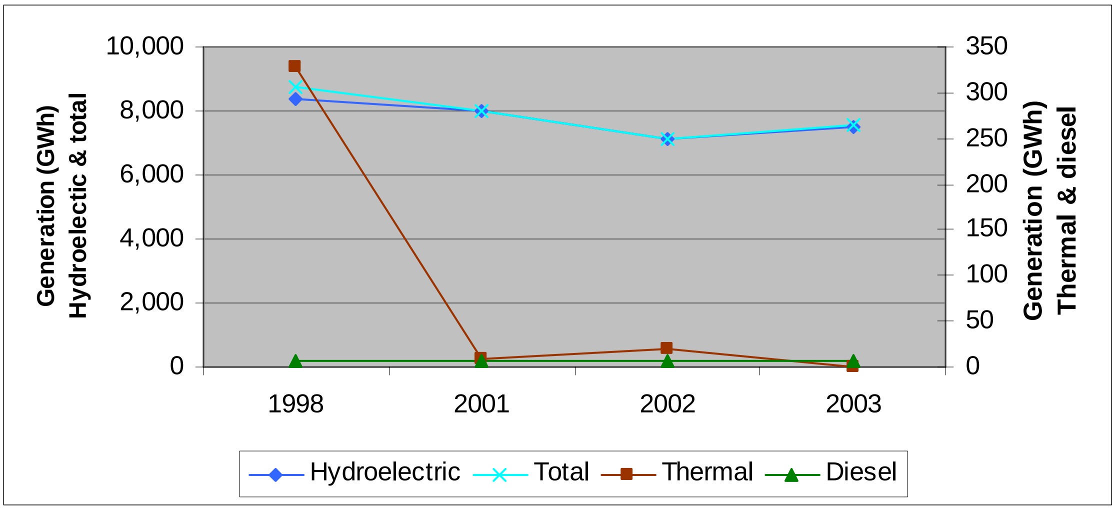
Source: Ministério de Minas e Energia, 2003

The high energy surpluses available for export maintain the pattern in the country's energy structure. Electricity is the only element contained within the exports, and around 98% of the electricity exported by Paraguay (according to the National Energy Balance scheme) is the energy granted by treaty to Brazil's and Argentina's markets, as a result of the lack of a domestic market (Viceministerio de Minas y Energía de la República de Paraguay, 2003).

Lastly, in Uruguay, data from the 1998-2003 period show the high incidence of hydroelectric sources, which account for nearly all generated energy. Figure 10.3 shows electric generation by source in the country.

As regards energy needs, the number of households may be considered a good indicator of the amount of energy needed to supply them. Table 10.2 shows the number of households served by electricity in the La Plata Basin, as well as the percentage of served households over the total.

Figure 10.3. Uruguay. Electric power generation by source (1998-2003)



Source: Genta *et al.*, 2004

Table 10.2. La Plata River Basin. Distribution of households with access to electric power by country[50]

Countries	Total Households	Households with Access to Electricity	
		Total	%
Argentina	7,382,660	7,044,051	95.4
Bolivia	389,231	193,958	49.8
Brazil	25,027,794	24,961,268	99.7
Paraguay	1,098,005	978,766	89.1
Uruguay	900,153	864,670	96.1

Note: Last registered data in provinces of Argentina, departments of Uruguay, states of Brazil and provinces of Bolivia included in the La Plata Basin.
Sources: INDEC, 2001; INE, 2001; IBGE, 2005 b; DGEEC, 2002; INE, 1996

10.2. Hydropower

10.2.1. Number and capacity of dams

There is over 100 hydroelectric plants operating in the La Plata Basin, most of which are found in the Brazilian sector. Three of the large reservoirs in the basin are binational: Yacyretá (Argentina-Paraguay), Itaipú (Brazil-Paraguay), and Salto Grande (Argentina-Uruguay).

Table 10.3 shows a description of the dams working in the basin, by country. In general, the largest number of dams in the basin is located on the Paraná River and its tributaries.

[50] See Annex I for the methodology used to calculate statistical information in the La Plata Basin.

Table 10.3. La Plata River Basin. Hydropower and large dams

Country and project name Dam name (hydro plant in brackets if different)	River Name	Dam height (m)	Year dam completed	Hydro capacity in operation (MW)
BINATIONAL				
Itaipú (Paraguay-Brazil)	Paraná	196	1982	12,600
Salto Grande (Argentina– Uruguay)	Uruguay	47	1979	1,890
Yacyretá (Argentina – Paraguay)	Paraná	43	1994	1,800
ARGENTINA				
Urugua-í	Urugua-í	90	1991	120
BRAZIL				
Ituparacanga	Sorocaba	38	1914	56.2
Itutinga	Grande	23	1955	52
Alecrim	Jupiá	54	1955	72
Peixoto (Mascarenhas de Moraes)	Grande	72	1956	478
Río Bonito	Bonito	19	1958	57
Jurimirim (Armando A. Laydner)	Paranapanema	50	1962	97
Furnas	Grande	127	1963	1,216
Jacuí	Jacuí	15	1963	180
Barra Bonita	Tietê	32.5	1963	141
Bariri (Alvaro de S. Lima)	Tietê	32.5	1965	143
Cachoeira Dourada	Paranaíba	26	1966	658
Graminha (Caçonde)	Pardo	60	1966	80
Jupiá	Paraná	43	1968	1,411
Ibitinga	Tietê	31.7	1969	131
Jaguara	Grande	55	1970	424
Xavantes	Paranapanema	98	1970	414
Passo Fundo	Passo Fundo	47	1972	226
Passo Real	Jacuí	58	1973	158
Ilha Solteira	Paraná	74	1973	3,444
Volta Grande	Grande	55	1974	437
Coaracy Numes – Paredão	Araguari	43	1975	70
Marimbondo	Grande	90	1975	1,440
Salto Osorio	Iguaçu	56	1975	1,096
Promissão	Tietê	50	1975	264
Boa Esperança	Paranaíba	53	1976	238
Capibara	Paranapanema	60	1976	640
Serraria	Jupiá	61	1977	24
Itaúba	Jacuí	97	1978	500
Saõ Simão	Paranaíba	127	1978	1,710
Agua Vérmelha	Grande	63	1979	1,396
Foz de Areira	Iguaçu	160	1980	1,676
Salto Santiago	Iguaçu	80	1980	2,000
Itumbiara	Paranaíba	110	1980	2,280
Jaguari	Jaguari	77	1981	28
Emborcação	Paranaíba	158	1982	1,192
Nova Avanhandava	Tietê	71	1982	348
Rosana	Paranapanema	30	1985	372
Segredo	Iguaçu	145	1992	1,260
Nova Ponte	Araguarí	142	1994	510

Country and project name Dam name (hydro plant in brackets if different)	River Name	Dam height (m)	Year dam completed	Hydro capacity in operation (MW)
Derivaçao Río Jordão	Jordão	95	1996	6.5
Miranda	Araguari	85	1997	408
Salto Caxias	Iguaçu	67	1998	1,240
Taquaruçú	Paranapanema	61	1999	555
Três Irmãos	Tietê	82	1999	808
Dona Francisca	Jacuí	n/a	2000	125
Itá	Uruguai	125	2000	1,450
Machadinho	Pelotas	126	2001	1,140
Jauru	Jauru	51	2003	n/a
Euclides da Cunha	Pardo	60	1960/77	109
Corumbá I	Corumbá	90	n/a	375
Estreito	Grande	92	n/a	1,040
Igarapa	Grande	32	n/a	210
Porto Colômbia	Grande	40	n/a	320
Manso (MT)	Manso	60	n/a	210
Porto Primavera	Paraná	38	n/a	1,814
Canoas I	Paranapanema	29	n/a	82.5
Canoas II	Paranapanema	25	n/a	72
Salto Grande	Paranapanema	25	n/a	70
PARAGUAY				
Acaray	Acaray	41	1972	256
URUGUAY				
Constitución	Negro	66	1982	333
Gabriel Terra/ Rincón del Bonete	Negro	51	1948	160
Rincón de Baygorria	Negro	45	1960	108

Considering the situation in each country, Argentina began to make use of the electric power coming from the rivers in the La Plata Basin in 1979, together with Uruguay, at Salto Grande. The most significant development was in 1994, together with Paraguay, when the binational Yacyretá dam started its operation (Mugetti, 2004).

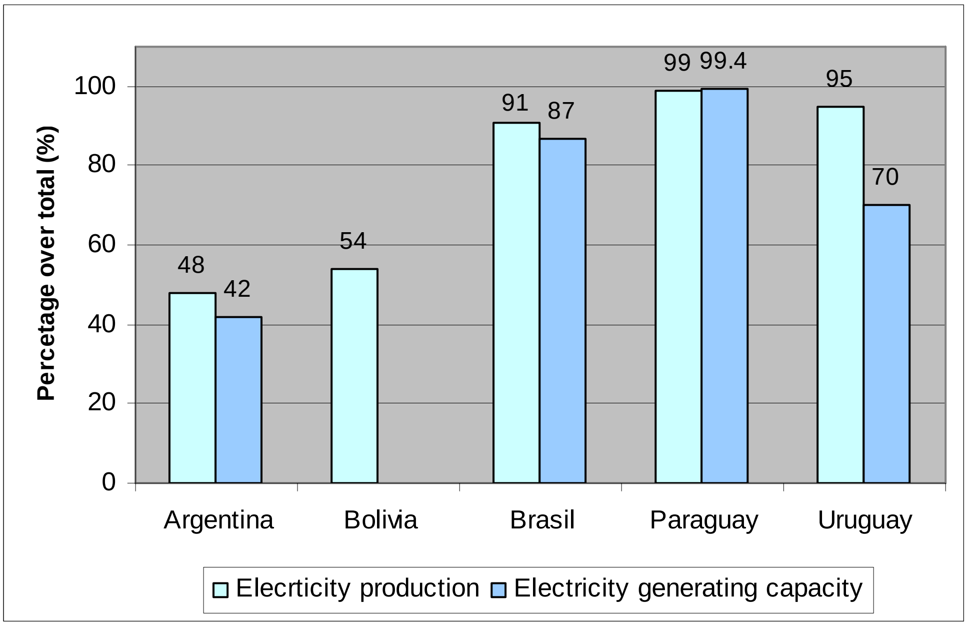
Although Bolivia lacks dams, it is estimated that virtually all of rivers'potential could be exploited, since this country has conditions to design hydraulic power stations, build a large part of the equipment (there exist three water turbine factories) and start the operation of the hydraulic power stations at a price which would be sensibly more competitive than photovoltaic systems. According to a project inventory carried out in the mid-1990s by the *Secretaría Nacional de Energía* (National Secretariat of Energy), it is possible to have installed capacities of 7 MW in microstations distributed in over one hundred projects, allowing supply to nearly 20,000 families (CEPAL, 2004 c).

Brazil possesses the second highest hydroelectric potential in the world, after Canada. Hydroelectricity has played a key role in the country's socioeconomic success. Even though estimations vary, Brazil's hydroelectric potential is 260 GW, of which only about 80 GW (31%) are being utilised now. One of the main characteristics of hydroelectricity is its unequal geographical distribution, with a higher concentration in the Amazon Basin, far from the large centres of demand, located in the Southeast (CEPAL, 2004 c).

In Uruguay, the estimated potential for hydropower is 1,815 MW (CEPAL, 2004 c), of which 1,546 MW have already been installed. Half of the 1,890 MW in Salto Grande dam correspond to Uruguay River, and 601 MW correspond to 3 stations on the Negro River.

The Figure 10.4 shows the proportion of hydropower in overall energy production by country. Those percentages show the importance of the hydropower generation in Brazil, Paraguay and Uruguay, as the previous statements pointed out.

Figure 10.4. La Plata River Basin. Proportion of hydropower in electricity production and generation capacity by country (1998)



Note: Information on electricity generating capacity in Bolivia was not found
Source: Baetghen *et al.,* 2001.

10.2.2. Current and future water demand for energy production

Since no information on current and future water demand for energy production has been found, an approximation for the future needs is given by the number of dams projected by the countries, which paints a picture not only of the potential water demand but also of the increase as energy generation in four of the five countries in the basin (Argentina, Bolivia, Brazil and Paraguay). Table 10.4 shows the existing dam projects, by country.

Table 10.4. La Plata River Basin. Dams projected by country in 2002

Project Name	River Name	Dam Height (m)	Hydro Capacity u/c or planned (MW)
BINATIONAL			
Garabi (Argentina-Brazil)	Uruguay	81	1,500
Corpus Christi (Argentina- Paraguay)	Paraná	40	2,880
Añacuá (Argentina-Paraguay)	Paraná branch	n/a	250
Arrazayal (Argentina-Bolivia)	Bermejo	120	93
Cambarí (Argentina-Bolivia)	Grande de Tarija	110	102
Las Pavas (Argentina-Bolivia)	Bermejo	110	88
ARGENTINA			
Chapetón	Paraná	15	3,000
BRAZIL (*)			
Capim Branco I	Araguari	55	240
Capim Branco II	Araguari	49	210
São João	Chopim	51	60
Barro dos Coqueiros	Claro	60	90
Caçú	Claro	38	65
Itumirim	Corrente	n/a	50
Corumbá III	Corumba	60	94
Salto Santiago 2	Iguaçu	65	710
Fundão	Jordão	52	119
Santa Clara	Jordão	70	119
Monjolinho	Passo Fundo	74	67
Pai Querê	Pelotas	158	292
Foz do Chapecó	Uruguai	48	855
Salto	Verde	n/a	108
Salto do Rio Verdinho	Verde	42	93

Note: n/a not available u/c under construction
(*) Many other planned hydro projects in Brazil are to be granted concessions by ANEEL. A further 2,734 MW was planned to begin before the end of 2002, and 6,390 MW in 2003
Source: UNEP, 2004

10.2.3. Impact of dams on the environment

- Paraná Basin

The construction of a large number of reservoirs in the main stretches of the Paraná River and their tributaries has caused the transformation of fluvial lotic systems into lentic or almost lentic ecosystems. Riparian river ecotones have become lake ecotones, considerably extending their total length, and the destruction of terrestrial habitats being a consequence of the impoundments that turned them into aquatic littoral habitats. As some of these reservoirs are binational developments, the ecosystem losses have impacted on the territories of the countries involved (UNEP, 2004).

Reservoir cascades in the main international stretches of the Paraná River (Argentina, Brazil and Paraguay) and their tributaries have also altered the habitats and interrupted the system continuity, affecting community structure and the population dynamics of migratory species of biological and commercial value (UNEP, 2004). The so-called "gas-bubble disease", produced by the supersaturation of gases due to the passage of water through dam spillways, leads to the formation of bubbles inside the blood vessels and tissues of the fish inhabiting downstream of the dams, as detected in Yacyretá reservoir (Argentina-Paraguay); the most affected species are in the group of the Siluriforms (Tucci, 2004).

Although published quantitative indicators reflecting the degree of transformation are not yet available, based on the compilation of graphic and written data, it is possible to state that over 35% of the total length of the Paraná River –about 2,570 km–, has been altered by the creation of large reservoirs like Ilha Solteira, Jupiá and Porto Primavera, in Brazil; Itaipú (Brazil-Paraguay), and Yacyretá (Argentina-Paraguay). A large number of reservoirs have also been built in the tributaries of the Paraná River, in Brazilian territory. Higher transformation rates of lotic environments into lentic and semi-lentic ones, of about, 36% in the Tietê and 46% in the Iguazú Rivers, 48% in the Grande River, and up to 64% in the Paranapanema River, are found there (UNEP, 2004).

The fauna of the reservoirs is poorer than the fauna of the rivers due to the decrease in flow velocity and the formation of a great pelagic area. As regards the Itaipú Reservoir, several researchers have described the changes in the fauna after river closure. Prior to the construction of the reservoir (1978-1981), there were 113 species of fish upstream of Saltos de Guayra, while only 83 species were found during the following years (UNEP, 2004).

The creation of a reservoir transforms fluvial riparian ecosystems into lake-type ones, notably increasing their longitudinal development, as well as changing terrestrial ecosystems into aquatic ones. The sum of reservoir areas by sub basin is a proxy indicator of the latter, which, in the case of reservoirs in the Paraná River, amounts to about 6,800 km^2. The total area of the main reservoirs in the Paraná system, including major tributaries, is over 16,000 km^2 (UNEP, 2004).

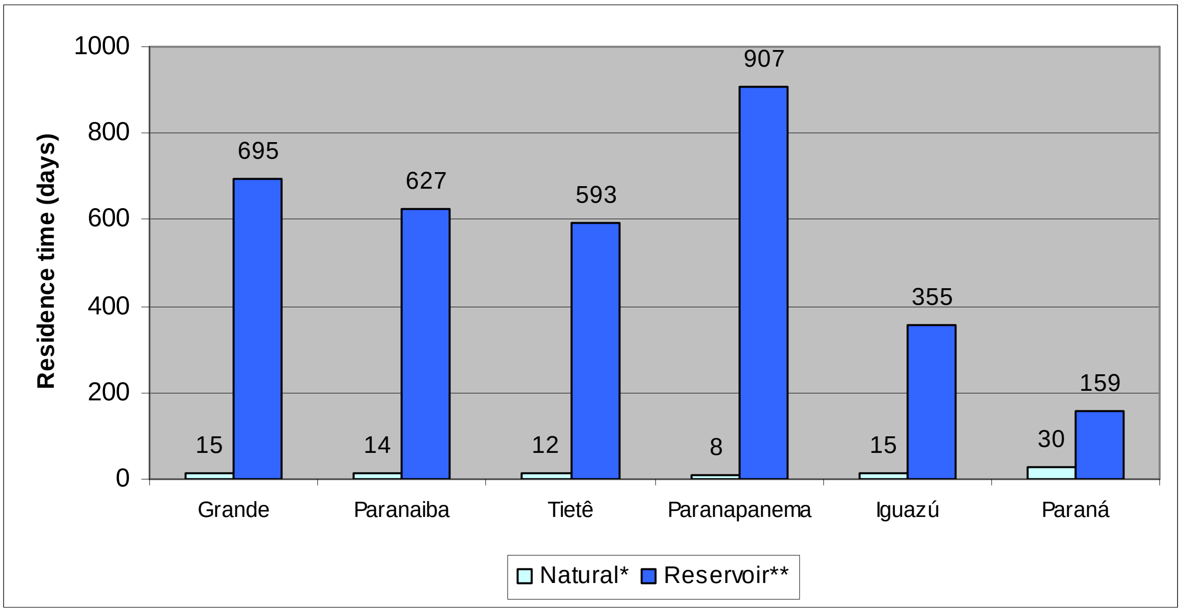
The natural hydrologic regime of the Paranaíba, Grande, Paranapanema, Iguaçu and Paraná rivers has also been significantly altered by the construction of several hydroelectric developments. The impact of the hydropower plants takes place in the upstream stretches, where the transformation of rivers into lakes alters the natural environment, where fish and other aquatic biota survive. This fact, associated with existing loads, leads to the eutrophication of these lakes, creating unsuitable water conditions, such as the appearance of algae, or the generation of gases and toxicity, which can bring about severe public health problems (Tucci, 2001). In addition, reservoir silting-up tends to create the conditions for floods in the upstream stretches (Tucci, 2004).

Downstream of the developments, depending on bypass configuration, water quality can be very poor, as flows are withdrawn with low concentrations of oxygen. Also, depending on the operational rules adopted by the powerhouse, there is a trend toward alteration in riverbeds, which has an effect on downstream flora and fauna (Tucci, 2004).

Several hydropower reservoirs have been built in the Iguazú River, and more particularly in its middle zone, which have changed the physical, chemical and biological features of the river. Such a cascade of reservoirs, including Salto Caxias, has transformed to over 40% of the lotic environments into lentic and semi-lentic ones. Before the commissioning of the Segredo Reservoir, aquatic vegetation has been characterised by rooted plants, whereas floating plants were extremely rare. Nowadays, as the environment has become lentic, floating macrophytes are favoured. As regards aquatic fauna, trophic web changes as well as structural modifications have been observed. Such changes might entail dramatic consequences for biodiversity, not only on account of the low amount of species in the Iguazú River but also because of their high endemicity. However, the fish community had already been affected by the Foz do Areia Reservoir, located upstream (UNEP, 2004).

Another interesting transformation indicator is the increase in average annual residence time in the various water subsystems. Figure 10.5 shows, in an indicative way, the situation before and after the construction of the reservoirs, revealing the significant transformations imposed on the natural fluvial environment (UNEP, 2004).

Figure 10.5. Paraná River Basin. Estimated annual residence times in both rivers and reservoirs



Notes: (1) Reference value assuming a mean annual flow of 1 m^3/s
(2) Calculated on the basis of reservoir volume.
Source: UNEP, 2004

Other impacts of shared hydroelectric developments such as Itaipú and Yacyretá are caused by lake pollution, a problem affecting water supply to cities like Encarnación, in Paraguay (Monte Domecq, 2004). The same problem has been recorded in Brazil upstream of the dams, affecting water quality as the flow is retained and oxygen concentrations decrease (Tucci, 2004).

- Uruguay Basin

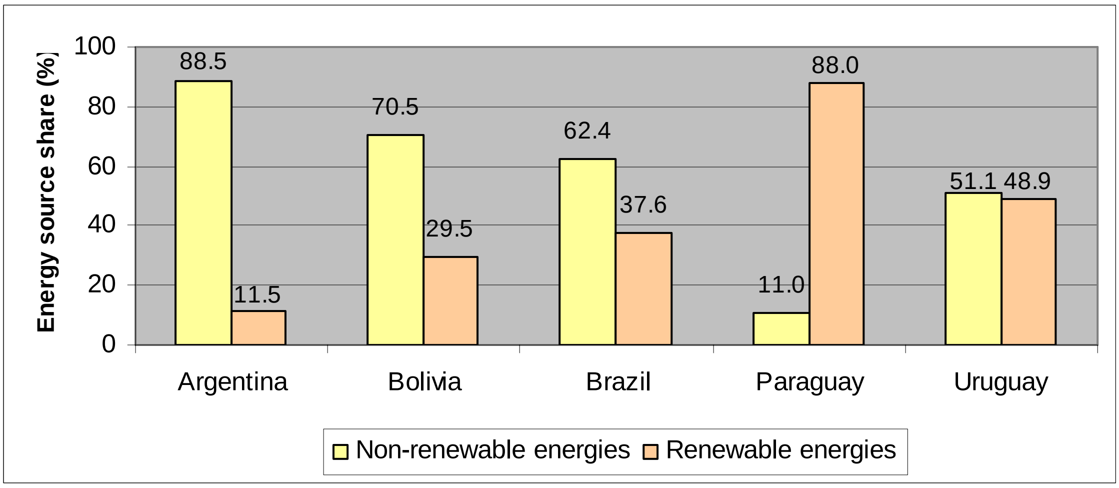
The Uruguay River is still a relatively unaltered watercourse, with almost a 10% of its lotic environment transformed into lentic and semi-lentic ones. The Salto Grande Reservoir –which spans over 500 km of coast and is shared by Argentina and Uruguay– has modified almost 8% of the Uruguay River's length (Mugetti, 2004). On the other hand, its flow rate fluctuates, producing a variation in river levels downstream from the dam and intensifying erosion on the river banks. Such an effect is even more evident on the gorge-like Uruguayan bank, in Salto

Department, which has severe signs of erosion and degradation. Both phenomena have altered the morphology of this riverbank, and have thus caused serious physical and biological damage in the area (Genta *et al*, 2004).

10.3. Alternative forms of energy

Energy generation in the basin is mainly based on the participation of traditional sources (Figure 10.6). As can be seen in Table 10.5, oil, natural gas and hydroelectricity energy are the most significant types of energy in the percentage distribution by country, according to a report published by CEPAL in 2004.

Figure 10.6. La Plata River Basin. Renewable and non-renewable energy source share in total energy supply by countries (2002)



Source: CEPAL, 2004c.

Information gathered from the same report and from the institutions in charge of the sector in each of the riparian countries reveals a picture of what is currently happening with non-traditional energy sources: wind, solar, and biomass decomposition energy.

10.3.1. Wind energy

This source of energy is being used in Argentina, Brazil, Paraguay and Uruguay, with different degrees of development.

In Argentina, the enforcement of Law 25,019 has allowed the development of an installed capacity of around 26 MW up to 2003, with a production reaching 75 GWh/year, and a mean load factor slightly over 30% (CEPAL, 2004 c).

In the case of Brazil, installed capacity is considerably lower –around 22 MW–, although it is increasing rapidly year after year. It is estimated that Brazil's wind energy potential varies between 20 and 140 GW. The highest potential is in the Northeast, which is, by the way, one of the poorest regions. It seems that wind energy can be finally developed in Brazil, since investments have been made in projects based on this kind of energy. On this line, the *Agência Nacional de Energia Elétrica*, ANEEL (National Agency of Electric Power) has already authorised more than 6 GW generated from wind energy (CEPAL, 2004 c).

Table 10.5 La Plata River Basin. Detail of Energy Source Share in Total Energy Supply by countries (2002)

Country/ Energy Supply (%)	Argentina	Bolivia	Brazil	Paraguay	Uruguay
Non-Renewable Energy	**88.5**	**70.5**	**62.4**	**11**	**51.1**
Oil	34.3	41.1	42.6	9	48.2
Natural Gas	50.8	24.4	6.0	---	0.7
Coal	1.3	---	7.0	---	0.1
Nuclear	1.7	---	1.1	---	---
Unsustainable firewood	0.3	4.3	0.3	3.0	2.1
Other Non-Renewable	0.1	---	0.1	---	---
Renewable Energy	**11.5**	**29.5**	**37.6**	**88**	**48.9**
Hydropower	6.6	17.0	14.8	52	36.8
Cane Products	1.6	7.4	12.5	---	0.4
Charcoal	0.4	0.2	2.7	1.0	---
Household Firewood	0.3	2.3	3.2	8.0	9.4
Industrial Firewood	---	1.4	1.5	2.0	1.4
Agricultural Firewood	---	---	0.6	---	---
Other Renewable	2.7	1.9	2.2	5.0	1.1

Source: CEPAL, 2004 c.

The situation, however, is quite different in Paraguay and Uruguay. Wind energy has not had a widespread use in Paraguay, at least with respect to electricity generation. Its availability (and availability variability) is an influential factor in the feasibility of its use as a renewable source. Several studies show utilisation possibilities in the areas of Pedro Juan Caballero and Ciudad del Este cities.

Strikingly, Chaco stations show very low average speeds (even below 2 m/s); studies related to rural electrification quote Chaco as being the region with the highest potential for wind energy exploitation, and so does the "empirical" experience of visits to the region. Nevertheless, the data available from measurements made at the beginning of 2004 –at points very distant from each other– suggest the contrary. As from a mean speed of 5 m/s, the wind option becomes appealing. The highest mean (monthly) speed recorded at the stations in the network of the *Dirección de Meteorología e Hidrología,* DMH (National Directorate of Meteorology and Hydrology) is of 5.9 m/s, in the month of June, at Capitán Miranda, Itapúa (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

Finally, a study of the assessment of wind potential in Uruguay, carried out by technicians in the Grupo de Trabajo en Energías Renovables de la Facultad de Ingeniería (Renewable Energies Workgroup of the School of Engineering), points out that the use of wind-originated electric power is technically feasible, although its economic feasibility is strongly influenced by the way in which the energy produced is valued (CEPAL, 2004 c).

10.3.2. Solar energy

Solar energy has been developed to a higher degree in Argentina, Brazil, Uruguay and Paraguay. In general, the theoretical potential of solar energy is enormous (primarily in Brazil), but it presents many limitations and gives rise to many doubts. As is the case in the rest of the world, it is extremely difficult to foresee what the role of solar energy will be in the region (CEPAL, 2004 c).

In Argentina there is an overall installed capacity in the form of photovoltaic solar energy for providing public services estimated at 5 MW in 2002. The estimated energy produced by this installed capacity would be in the order of 7 Mwh/year (CEPAL, 2004 c).

Bolivia is currently applying the *Programa de Energías Renovables* (Renewable Energies Programme), which proposes the combined implementation of distribution line-laying, local systems, and decentralised electric power plants, mainly based on solar energy, with the aim to achieve a 45% coverage and add 60 MW of the demand until 2007 (CEPAL, 2004 c).

In the case of Brazil, numerous technological advancements are still required for solar energy to be practicable. At the beginning of 2000s, there exist approximately 6,000 small projects with a capacity of 3,000 kW in various applications, but mainly for water pumping and lighting. As an average, Brazil receives 230 Wh/m^2 of solar radiation, placing the country in a privileged position to make good use of this potential (CEPAL, 2004 c).

Solar energy exploitation in Paraguay has not been widely spread yet. There are a number of studies about this subject, but none of them have passed to the execution phase, only except at an experimental level. In addition, such studies focus primarily on the thermal solar option, mainly as a substitute for biomass fuels in food cooking. There are also studies of alternative uses, solar driers being the most significant.

The lowest solar radiation identified in the country is of 16.2 MJ/m^2/day (annual average), at the Salto del Guairá station. Spread is minimal (the maximum is 18.2 MJ/m^2/day), so its availability can be said to be quite uniform. Estimates forecast a value of 1.73 MWh/m^2 of annually available energy (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

In spite of the fact that there is a large potential market for decentralised rural electrification, only two entities providing solar energy equipment/services exist in the country. One is CEDESOL (an NGO having its headquarters in Asunción), which works with rural and aboriginal communities, focusing on the social benefit of alternative solutions based on solar energy. The second entity is a private company providing its services within a typically commercial scheme, offering photovoltaic solutions to isolate agricultural and livestock establishments which require electricity and services such as water pumping, buoyage and often residential lighting. Both organisations have identified the lack of funding for the purchase of equipment and the lack of dissemination of information as the main barriers preventing a larger penetration of their services (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

10.3.3. Biomass

This source of energy is used in Bolivia, Brazil, Paraguay and Uruguay. In general, the theoretical global potential of biomass energy is broad, even though only a small fraction can be considered to be available on a sustainable basis and at competitive prices. This, however, is likely to change over time. By nature, biomass energy is much more complex and difficult to measure than most of the other resources. Most energy scenarios include biomass as an important element for energy supply in the future (CEPAL, 2004 c).

Biomass-derived residues make up a vast, underexploited energy resource, and present numerous opportunities to be efficiently used, since they can be readily available, thus being a good opportunity at a low cost. The most important residues are agricultural and forest waste, manure, and –more controversially– urban solid waste. Many attempts have been made at estimating the global energy potential of agricultural waste, but this is an extremely difficult task, and only rough estimations can be reached (CEPAL, 2004 c).

In this regard, Brazil produces an enormous amount of residues (250 to 275 Mt/year) from commercial crops alone. It is also a world leader in big industrial applications of biomass energy and has one of the world's largest potentials. In addition, it possesses the world's biggest native forest reserves (at least 400 Mt of firewood could be exploited on an annual sustainable basis). Bagasse potential ranges from 1.1 to 47 GW (compared to the installed capacity of about 1,000 MW, mainly of bagasse); and approximately 1,800 MW of paper and cellulose (the current installed capacity is just over 600 MW). These resources have not been exploited to an adequate extent yet, and have not been registered in the accounts either. Brazil is in a unique, privileged position to increase biomass energy consumption, because it offers considerable potential for diversification (CEPAL, 2004 c).

Biomass reached its zenith after the creation of the *Programa Nacional de Alcohol* (National Alcohol Programme) in 1975. Since early 2004, alcohol was mixed with gasoline in a proportion of 25%, and this renewable fuel is sold at the country's gas stations without subsidies and at highly competitive prices. Besides, at the beginning of 2000s, research was being carried out on other biofuels and conveyors, such as biodiesel and ethanol hydrogen. Some innovative end-use technologies are already competing in the market (CEPAL, 2004 c).

Bolivia has seen the recent creation of a cogeneration unit of 15MW at the Unagro Sugar Factory in Santa Cruz de la Sierra city, which uses bagasse as fuel. Also in the Santa Cruz Department, two projects use rice husks as fuel for a sugar mill, and bagasse for the production of *chancaca* (sugar cane syrup). This kind of endeavours will lead to a rise in the competitiveness of the Bolivian agricultural industry and to a rational increase in the consumption of renewable energies. This field provides a wide range of opportunities, given the existing potential in the sugar cane and lumber industries in Bolivia (CEPAL, 2004 c).

Paraguay had, until the early 1990s, a prevalence of rural population in its population structure. The abundance of forests (50% of the national territory was covered by forests in the 1960s), the fact that hydrocarbons were not produced in the country, and the eating habits of the population promoted food cooking –especially in rural environments– by means of firewood burning through very-low-efficiency processes. On the other hand, the largest energy requirements in the Paraguayan industrial sector are related to thermal needs. Many of the raw materials used in the industry contain combustible waste (coconut husks, rice husks, sugarcane bagasse, etc.), which is used to meet energy requirements. There is also a widespread use of firewood boilers in the industry. All this means that biomass was and still is the main fuel in the sector (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

A reasonable part of the firewood gross domestic supply is destined to coal industries (with a very low performance in most cases), which produce charcoal for both industrial use and residential use, where it is used for food cooking in peripheral areas around the big cities (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

Estimations for 1996 indicated that the demand for firewood as an energy source (including firewood for charcoal) accounted for approximately 50,000 ha/year in Paraguay's forests, very little of which was recovered by sustainable management. Estimates for the year 1990 made by the *Secretaría Técnica de Planificación* (Technical Secretariat of Planning) showed that firewood consumption with energy purposes accounted for around 15% of the overall deforestation of the eastern region of Paraguay. Biomass –especially firewood– has had a noticeable significance in the energy menu (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

In Uruguay, biomass waste is used in the industrial sector (39.1 KTOE[51]) and, in part, for electricity self-generation (2.7 KTOE). Firewood final energy consumption in 2002 was 374.7 KTOE; 1.5 KTOE was destined to coal industries and 0.5 KTOE to electricity self-generation. As regards the final consumption of firewood, 301.7 KTOE correspond to the residential sector, 3.1 KTOE to the commercial sector, and 69.9 KTOE to the industrial sector. The industrial consumption level reached 190 KTOE in 1992 (due to the substitution of gas oil by firewood) and has been diminishing in the last few years owing to the low price of fuels. Whereas the level for the industrial sector is estimated on the basis of surveys to the industrial sector, the residential sector and commercial sector levels remain stable and identical to the levels obtained in the surveys carried out 20 years ago. Levels might be lower at the beginning of 2000s, but there are no available studies by which they could be established (CEPAL, 2004 c).

Only firewood and biomass waste (rice husks, sunflower husks, bagasse) are included in the national energetic structure of renewable sources. Within final energy consumption by source in 2002, 17.1% corresponded to firewood and charcoal, and 1.8% to biomass waste (CEPAL, 2004 c).

10.3.4. Geothermal power

It is necessary to note the activities recently started by Argentina, Brazil, Paraguay and Uruguay, with the financial support of the Global Environmental Facility, GEF, in relation to the potential development of the Guaraní Aquifer System with a view, among others, to capturing energy from the geothermal resource (CEPAL, 2004 c).

In Argentina, the Copahue plant (province of Neuquén, outside the La Plata Basin) has an installed capacity of 600 Kw and is currently inactive. The province authorities are studying the possibility to reopen the plant and start other activities related to, for instance, using this

[51] KTOE: Kilo Tonnes of Oil Equivalent

energy for street heating and the potential development of tourism opportunities (CEPAL, 2004 c).

10.4. Goals and strategies for future energy demand

10.4.1. Argentina

With regard to renewable energy sources, Argentina's government strategy[52] takes into account, firstly, the development of small hydroelectric developments (up to 15 MW), since this kind of project represents an opportunity for sustainable development for multiple geographical regions (CEPAL, 2004 c). On this line, there is a catalogue of small hydroelectric developments in approximately 120 projects concentrating a potential that has been estimated at approximately 200 MW. Also, an update on the economic assessment has been initiated, especially for those cases substituting fuels of combustible fossil origin. Such projects could make a more efficient use of water and energy in areas with irrigation, which would lead to applying the possibilities for regional productive uses and therefore for employment opportunities (CEPAL, 2004 c).

The importance of renewable resources as alternative sources for generating electric power in rural sectors has been increasing due to the *Programa de Abastecimiento Eléctrico a la Población Rural Argentina*, PAEPRA (Programme for Electricity Supply to the Argentinean Rural Population), carried out by the *Secretaría de Energía de la Nación* (National Secretariat of Energy) through the *Dirección Nacional de Promoción* (National Directorate of Promotion), with the aim to reach a basic electricity supply for lighting and communications using renewable technologies such as photovoltaic, wind, and biomass systems, and mini hydraulic systems (CEPAL, 2004 c).

It should be mentioned that there is a bill at the national level to foster renewable sources of energy destined to electric power production. This bill –being debated in 2004– sets forth the goal of reaching a renewable energy source contribution of 8% of national electric power consumption by the end of 2013. It also includes the creation of an investment pattern for the construction of energy-generating works using renewable sources and the granting of certain benefits affecting some performing regimes, such as income tax, value added tax, import duty and fiscal stability (CEPAL, 2004 c).

Finally, the development of non-renewable energy is being promoted too, through the *Plan Argentina*, which consists in an exploration plan offering over 180 areas on shore and off shore, in productive and non-productive petroleum basins. Bids for the areas would be invited with exploration licenses, and, if hydrocarbons were discovered, exploitation franchises would be granted according to Law 17,319, with free availability (Secretaría de Energía de la República Argentina, 2004). Other endeavours include expanding the gas pipeline network and other incentives to the exploration and exploitation of hydrocarbons. These are contained, as well as the expansion of hydroelectric power, in the energy plan for the 2004-2008 period.

[52] A detail of policies and legislation related to the energy topic in Argentina is included in Annex III.

10.4.2. Bolivia

In Bolivia, the *Estrategia Boliviana de Reducción de la Pobreza*, EBRP (Bolivian Strategy for Poverty Reduction) includes strengthening the *Programa de Electrificación Rural*, PRONER (Rural Electrification Programme), partially implemented during the 1990s. This strengthening scheme promotes the inclusion of renewable energies, with the general goal of eliminating financial, institutional, technical and human resources barriers, in order to achieve the successful execution of projects and start a sustainable, replicable programme in other rural areas in the country. Expansion to a second PRONER phase will involve connecting around 200,000 additional rural households to the electric system. Thus, a coverage goal equivalent to 40% of rural households would be reached in 2006 (Gobierno de la República de Bolivia, 2001).

In order to attain these goals, the existing network will be expanded, new hydroelectric power stations will be built, and existing thermal power stations will be converted using non-conventional energy sources according to PRONER analyses and forecasts (Gobierno de la República de Bolivia, 2001).

10.4.3. Brazil

In Brazil[53], hydroelectricity is crucial in the national energetic structure. As already stated, the Paraná Basin has the highest concentration of hydroelectric developments in the country. As well as planned endeavours, there are installation forecasts for small hydroelectric power stations, requiring greater public participation in decision-making (see Box 10.1), with a view to looking after the interests of society and the environment (Tucci, 2004). In such a context, it should be stressed that the rapid development of the Brazilian hydroelectric sector has led to implementing efforts to improve the integration of socio-environmental variables in the decision process, looking to provide more legality and transparency to the whole process. More recently, the adoption of the Strategic Environmental Assessment methodology in the planning phases for energy supply expansion should be pointed out (Tucci, 2004).

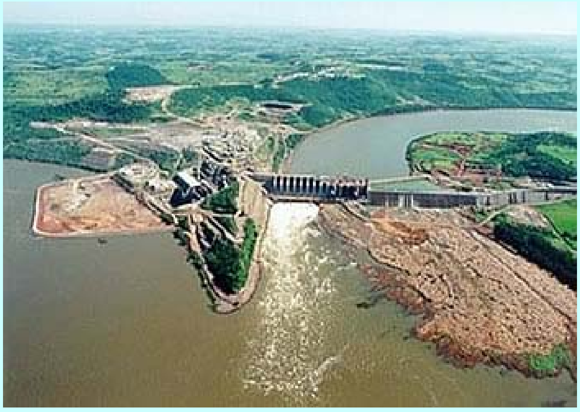
The main problem lies in determining how this resource can be integrally used in an environmentally sustainable way and at an economically and financially acceptable cost. This is a key aspect, warranting restating the hydroelectricity scheme in Brazil. A large part of this potential is still unexplored. Therefore, in spite of the existing uncertainties, hydroenergy will continue to be the main source of electricity generation in Brazil over the next few decades (CEPAL, 2004 c).

The administration started in early 2003, opened up the possibility for replacing the energy industry model (New Model). The reform consists in the total restructuring of Brazil's earlier energy model, which was not able to avoid the 2001 energy crisis. The fuel compensation fund (*Conta de Consumo de Combustiveis,* CCC [Fuel Consumption Account]) policy intends to expand access to energy in isolated communities. Nevertheless, there are still some obstacles, such as the high consumption of extra diesel for sea transport, the difficulty in guaranteeing supply, the larger reliance on gas oil imports and the polluting emissions (CEPAL, 2004 c).

[53] A detail of policies and legislation related to the energy topic in Brazil is included in Annex III.

Box 10.1. Public participation in the resettlement of affected people by Salto Caxias reservoir

Figure 10.7. Salto Caxias Dam and Reservoir



Source: http://abcp.org.br

The Salto Caxias hydropower project in Brazil has a capacity of 1,240 MW and was completed in 1999. It is the fifth dam built on the Iguaçu River and the first one planned under the environmental regulations stipulated in the Brazilian Constitution of 1998. The measures taken to comply with the new environmental legislation at Salto Caixas amounted to about one-quarter of the total project cost. However, the environmental impact assessment was only undertaken after the project was approved and land had been acquired, putting political pressure on the process. This resulted in a poor quality EIA study (WCD, 2000).

Social organisations and affected communities exerted public pressure based in part on unsatisfactory resettlement outcomes for previous dams. This situation led to the establishment of a "resettlement committee", which created a forum to address conflicts and meet requests of the affected people. A negotiation process involved the committee of affected people in developing an acceptable relocation programme for displaced people. Views of local people were also incorporated into the monitoring stages of the project (WCD, 2000).

Renewable energy sources, such as photovoltaic energy, biomass, and small hydroelectric power stations, among others, which can be supplied with local resources, can guarantee supply (once they have used local resources), have a much smaller environmental impact, and contribute to energy autonomy, among other things (CEPAL, 2004 c). The *Ministerio da Ciência e Tecnologia*, MCT (Ministry of Science and Technology) has developed special programmes aiming at fostering technological research and innovation in electricity generation from new low-cost sources, with the goal of developing the national industry of technology and human resources (CEPAL, 2004 c). In addition, the *Ministerio de Minas e Energia,* MME (Ministry of Mines and Energy) coordinates the *Programa de Incentivo às Fontes Alternativas de Energia Elétrica*, PROINFA (Alternative Sources of Electric Energy Incentive Programme). This is a major tool for diversifying the national energetic structure, guaranteeing more supply reliability and safety. Coordinated by the MME, the Programme institutes the dealing of 3,300 MW of energy by the *Sistema Interligado Nacional,* SIN (Interconnected National System), produced by wind and biomass sources, and by small hydroelectric power stations, with 1,100 MW from each type of source (Ministerio de Minas e Energía, 2005 c).

On the participative management line, the partnership of the Brazilian society during the energy crisis in early 2001 should be underscored, showing that information and participation represent actual pillars for the management process (Tucci, 2004).

10.4.4. Paraguay

In Paraguay there is a joint venture between the *Viceministerio de Minas y Energía*, VME (Viceministry of Mines and Energy), the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF) for reducing greenhouse effect gas emissions resulting from fossil sources used by rural families to meet their energy needs (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

It is estimated that project works will be carried out over five years, involving the supply to 7,500 families –accounting for 5 % of the total–; the removal of barriers inside areas of legislation and regulation; training, publication, certification and financial strengthening which prevent the expansion of the renewable energy market; as well as the promotion of existing private companies and the creation of new companies for expanding this market niche (Viceministerio de Minas y Energía de la República de Paraguay, 2004).

At 2004 the *Plan Nacional de Energía de la República del Paraguay* (National Energy Plan of the Republic of Paraguay), was undergoing the bidding process, in which the VME was partaking. The Plan is backed by the cooperation of the Spanish Government, through the *Fondos de Estudio de Viabilidad,* FEV (Viability Study Funds). Also, the Yacyretá-Ayolas 500-kV transmission line was being built for transmitting energy from the Yacyretá hydroelectric power station, as well as a 66-kV transmission line connecting Paranambú and Naranjal, in order to better meet the area’s demand.

With respect to large hydroelectric power stations, the Paraguayan Government has recently agreed with the Argentinean Government to raising the Yacyretá reservoir height and building Corpus Christi dam. It is expected that this will lead to a significant increase in the hydroelectricity generation capacity.

10.4.5. Uruguay

There are no explicit or implicit policies for using renewable sources in Uruguay (CEPAL, 2004 c). As regards solar-energy-based rural electrification, there are rural electrification plans complying with *Administración Nacional de Usinas y Transmisiones Eléctricas*, UTE (National Administration of Power Stations and Electric Transmissions) resolutions at the company level. These correspond, however, to each company’s own policy, and do not apply at the country level. Other rural electrification plans are based on line lying rather than on renewable sources (CEPAL, 2004 c).

Out of its own initiative, UTE has installed photovoltaic solar panels in rural schools, police stations, and polyclinics –in all, around 70 places far from the network–. A similar plan was also being developed at the beginning of 2000s, with World Bank funds, determining that those in the rural area without electricity coverage who are interested will have to pay $100/month (approximately US$3.5/ month) for the installation of a 50W panel. Lastly, according to the information provided by UTE, it is estimated that the national electricity coverage is of 97% (CEPAL, 2004 c).

10.5. Policy and legislation on energy

10.5.1. Argentina

The energy policy is led by the *Secretaría de Energía* (Secretariat of Energy), depending on the *Ministerio de Planificación Federal, Inversión Pública y Servicios*, MINPLAN (Ministry of Federal Planning, Public Investment and Services). The Secretariat has extensive powers and is in charge of all matters associated with energy production, transportation and commercialisation countrywide, with a method of federal coordination with the provincial jurisdictions, which oversee its performance and propose the regulations to facilitate its execution (Presidencia de la Nación Argentina, 2003 a).

10.5.2. Bolivia

In Bolivia, the energy production sector is controlled by two governmental bodies: the *Ministerio de Minería e Hidrocarburos* (Ministry of Mining and Hydrocarbons) and the *Viceministerio de Electricidad y Energías Alternativas*, VME (Viceministry of Electricity and Alternative Energies), depending on the *Ministerio de Obras Públicas* (Ministry of Public Works).

The former has the main goal of generating policies for the competitive development of hydrocarbons and mining sector activities in the country. In the case of the hydrocarbons sector, specifically, one of the objectives of the national policy to advance the country's economic development is to foster this sector and monetise natural gas reserves by implementing export projects and carrying out projects that incorporate added value (Ministerio de Minería e Hidrocarburos de la República de Bolivia, 2004).

Over different administrations, the Bolivian state has been aiming at the development of the oil industry and, as a consequence, the integral development of the country. Due to an awareness of the lack of economic resources to foster this industry, and as a result of past hydrocarbon exploitation efforts without the expected results, the need arose to look for and promote new alternatives backed by legal regulations. Consequently, in the 1950s, the need was seen to pass laws that would allow the development of this activity. The need was felt for private capital tenders and for constantly looking to incorporate advanced legal, economic and technical regulations harmonising with the situation of the country and the interests of the Bolivian people (Ministerio de Minería e Hidrocarburos de la República de Bolivia, 2004).

The VME, under the control of the *Ministerio de Obras Públicas*, is the state agency responsible for the electricity (non-hydrocarbon energy) sector. It aims at the sector's sustainable development with a view to achieving the progress of the country and the welfare of the population. Its main goals are reaching sector competitiveness, increasing electricity coverage, consolidating energy export projects, interconnecting currently isolated systems, and gradually substituting the non-renewable sources (diesel, gas oil) used in electric generation (Viceministerio de Electricidad y Energías Alternativas de Bolivia, 2004).

10.5.3. Brazil

The MME was created by Law 3,782 on July 22, 1960. Before that, mining and energy affairs were managed by the *Ministério da Agricultura* (Ministry of Agriculture). In 2003, Law 10,683/2003 defined as MME´s competences the areas of geology, mineral and energy resources, water power development, mining and metallurgy, and oil, fuel and electric power, including nuclear energy. The structure of the Ministry was regulated by Decree 5,267, on December 9, 2004, which created: *Secretaria de Planejamento e Desenvolvimento Energético* (Secretariat of Energy Planning and Development); *Secretaria de Energia Elétrica* (Secretariat of Electric Power); *Secretaria de Petróleo, Gás Natural e Combustíveis Renováveis* (Secretariat of Oil, Natural Gas and Renewable Fuels); and *Secretaria de Geologia, Mineração e Transformação Mineral* (Secretariat of Geology, Mining and Mineral Transformation) (Ministério de Minas e Energia, 2005 a).

On March 15, 2004, Law 10,847 authorised the creation of the *Empresa de Pesquisa Energética*, EPE (Energy Research Company). Linked to the MME, the EPE aims to provide services in the area of studies and research destined to subsidise energy sector planning (Ministério de Minas e Energia, 2005 a).

Companies linked to the MME are Eletrobrás and Petrobras, which are of mixed economy. Eletrobrás, in turn, controls the companies *Furnas Centrais Elétricas S.A.* (Furnas Electric Power Stations), *Companhia Hidro Elétrica do São Francisco,* CHESF (São Francisco Hydroelectric Company), *Companhia de Geração Térmica de Energia Elétrica,* CGTEE (Company of Thermal Electric Power Generation), *Centrais Elétricas do Norte do Brasil S.A.*, ELETRONORTE (Northern Brazil Power Stations), *Eletrosul Centrais Elétricas S.A.,* ELETROSUL (Eletrosul Power Stations) and *Eletrobrás Termonuclear S.A.*, ELETRONUCLEAR (Thermo-nuclear Eletrobrás). Public enterprises *Comercializadora Brasileira de Energia Emergencial*, CBEE (Brazilian Emergency Power Trading Company) and *Serviço Geológico do Brasil* CPRM (Brazil Geological Service) are also associated to the MME. The autarkies linked to the Ministry include the national agencies of electric power and of oil and the *Departamento Nacional de Produção Mineral,* DNPM (National Department of Mineral Production).

The regulating agencies under MME control are ANEEL and *Agência Nacional do Petróleo,* ANP (National Oil Agency). ANEEL was created by Law 9,427, in 1996. An autarky with a special regime, linked to the MME, its functions are to regulate and supervise electric power generation, transmission, distribution and commercialisation; to mediate in case of conflicting interests between electric sector agents or between these and the consumers; to grant, allow and authorise energy installations and services; to guarantee fair rates; to watch over the quality of the service; to demand investments; to stimulate competition among operating firms and guarantee the generalisation of the services (Ministério de Minas e Energia, 2005 a).

ANP was created by Law 9,478, in 1997. An autarky linked to the MME, its function is to promote the regulation, contracts and supervision of oil industry economic activities (Ministério de Minas e Energia, 2005 a).

The main MME political line is the introduction of the *Plan Luz para Todos* (Plan Light for All), which started in 2005 and has a seven-year time limit. The objective is to achieve electricity coverage in all the households in the country. Since deficiencies are most marked in the poorest sectors, the Government's goal is to use energy as a factor for social and economic development in these communities, contributing to poverty reduction and an increase in household income. The arrival of electric power will facilitate the integration of federal government social programmes, as well as access to health, education, water supply and sanitation services. The program will be started in all Brazilian states with the installation of State Managing Committees (Ministério de Minas e Energia, 2005 b).

10.5.4. Paraguay

The institutional framework of the Paraguayan energy sector is characterised by the participation of the state as an authority and as a business owner, and by institutional dispersion, mainly with state enterprises. The state is in charge of business management in the electric power and hydrocarbon sub sectors. In the case of the electric power sub sector, the state enterprise *Administración Nacional de Electricidad*, ANDE (National Electricity Administration) exercises the legal monopoly of the electricity public service. In the hydrocarbon sub sector, *Petróleos Paraguayos,* PETROPAR (Paraguayan Oils) is authorised to industrialise oil and to exercise the legal monopoly in the import of crude oil and diesel oil. Survey and exploration activities are granted by the state to foreign and national private companies for a given period of time (Viceministerio de Minas y Energía de la República de Paraguay, 2005).

The creation of the *Subsecretaría de Minas y Energía* SSME (Undersecretariat of Mines and Energy) in 1990 –transformed in the *Gabinete del Viceministro de Minas y Energía*, GVME (Cabinet of the Viceminister of Mines and Energy) in 2005– as a body controlled by the *Ministerio de Obras Públicas y Comunicaciones*, MOPC (Ministry of Public Works and Communications) was the first step towards facilitating the coordination of the sectors. Law 167/93 confers the GVME the quality of ruling institution in the national energy sector (Viceministerio de Minas y Energía de la República de Paraguay, 2005).

The GVME is working on consolidating its position as the energy sector ruling institution. This is shown by the advancements in the coordination among institutions and among sectors, specifically regarding the development of certain projects, and the status given by the National Government to the Ministry of Public Works and Communications through the GVME of representing the interests of the Paraguayan state in the energy sector before several international bodies and forums. Nonetheless, there are still legal adjustments to be made in order to establish a more integrated and consistent institutional structure (Viceministerio de Minas y Energía de la República de Paraguay, 2005).

10.5.5. Uruguay

The *Dirección Nacional de Energía y Tecnología Nuclear*, DNETN (National Directorate of Nuclear Energy and Technology), controlled by the *Ministerio de Industria, Energía y Minería*, MIEM (Ministry of Industry, Energy and Mining), is responsible for proposing and coordinating national policy in matters of energy, as regards both fuels and electric power, as well as for regulating, supervising and controlling activities involving the use of nuclear technology (Ministerio de Industria, Energía y Minería de la República Oriental del Uruguay, 2004).

PART D - MANAGEMENT CHALLENGES

Challenge: Managing risks

<u>Overview</u>: *It is of great importance to ensure that human beings and ecosystems are secured from floods, droughts, pollution and other water-related hazards.*

11. Climate change and variability

11.1. Observed climatic variation and long-term projections

In the XX Century, the La Plata Basin used to be the sub-continental region with the highest positive precipitation trend in the world (Barros *et al.,* 2004). Rainfall variability in most of southern South America has important interdecadal components. The strongest interdecadal variability in the annual cycle of precipitation occurs in regions of transition between precipitation regimes, especially in the Paraná River Basin. In subtropical Argentina, annual precipitation also shows oscillations with periods from 7 to 10 years. On this time scale, there is a close relationship between temperature and precipitation regimes (Baetghen *et al.*, 2001).

Precipitation trends in Argentina have been positive since 1916 and even increased after the late fifties. This behaviour is consistent with a climatic jump around the 1960s, when the southern portion of South America experienced significant warming. Precipitation increased by up to 30% between 1956 and 1991 in several localities between 20° S and 35° S east of the Andes. In a large part of this region, most of the increase occurred during the 1960s, and it seems to have been associated with a reduction of the meridional gradient of surface temperature, which probably caused a southward shift of regional circulation. Consistently, the leading principal component of annual precipitation correlates with the meridional gradient of temperature at interannual as well as interdecadal timescales (Baetghen *et al.*, 2001).

Another strong precipitation increase was observed during the late 1970s. This correlates with an increase in the subtropical temperature of the Southern Hemisphere. The positive trend in precipitation during 1956-1991 has facilitated a southward extension of the agricultural frontier in Argentina, increasing available lands by the 1960s in an amount that exceeds 100,000 km^2 (Baetghen *et al.*, 2001).

Trends in precipitation over the basin prior to the 1960s have also been detected. A linear trend has been reported in the monthly and annual rainfall in part of the province of Buenos Aires. Decreased precipitation in subtropical Argentina tends to be associated with enhanced westerly flow in Patagonia. The negative trend in the subtropical region in the 1931-50 period could be associated with a slowing of the westerlies over Patagonia. Significant negative correlations have been obtained between westerly flow and rainfall in eastern Argentina (Baetghen *et al.*, 2001).

The La Plata Basin has been permanently influenced by climate variability, with consequent variations in river levels. Fluctuations have reached extremes, frequently producing high and low stages. The basin's flow rate –especially in the Paraguay, Paraná and Uruguay rivers– exhibited a negative trend from 1901 to 1970, but reversed after this period. Variability across decades has also been observed in the basin's discharge patterns. Moreover, there are written reports of alternating flood and drought periods during the 16th and the 18th centuries, which bears proof to a marked natural variability (IPCC, 2001).

The increase in precipitation has gone hand-in-hand with a similar trend in the rivers' flow rates. The biggest increase in precipitation occurred between the 1960s and the 1990s. Besides, extreme precipitation in Argentina has increased remarkably in frequency since the end of the 1970s, so much that it has tripled in some cases. It should be mentioned that such events lead to local floods when the conditions of the terrain hamper runoff or concentrate it in specific places (Barros *et al.*, 2004).

Mean annual flow rates in the three largest rivers of the La Plata Basin reveal the onset of a markedly positive trend since the beginning of the 1970s. Floods of all sorts have also become more frequent. Over 80% of the most significant high flows in the Paraná and Paraguay rivers during the 20th Century were observed in the past 30 years, which bears proof to the high impacts produced by regional climate change on the intensity and frequency of floods in the larger rivers of the basin (Barros *et al.*, 2004).

Precipitation is the main driver of variability in water balance through space and time, and changes in precipitation patterns entail significant consequences for hydrology and freshwater resources. Flood frequency is affected by interannual precipitation variability and by changes in short-term characteristics. Changes in seasonal rainfall distribution and interannual variability of low and high flow rates produce a major effect on low stages and lengthy droughts (Baetghen *et al.* 2001).

Even though the way in which global warming may affect the frequency and intensity of extreme events is still uncertain, extraordinary combinations of river and weather conditions have historically unleashed disasters in some parts of the La Plata Basin. This natural variability must be added to the potential impact of climate change resulting from human activities. Both cities and other types of settlements lying on the banks of the larger rivers of the basin –especially in the Northeast of Argentina– have been affected by floods (Baetghen *et al.* 2001).

An increase is expected in the frequency and magnitude of extreme events such as floods in connection with El Niño. The La Plata Basin is one of the most sensitive regions to this phenomenon. Evidence has been gathered on the increasing flow rate anomalies observed in the La Plata Basin during recent El Niño events. The maximum monthly discharge patterns in the Paraná River increased by twofold and six fold vis-à-vis normal values during El Niño events occurring in 1982-1983, 1992, 1994 and 1997-1998 (Moyano, 2001). In previous El Niño events (1902-1977), the Paraná River flow rates had been between one and two times above the normal maximum monthly values. Despite the fact that the impact of El Niño varies in magnitude, it has been suggested that its frequency has increased in recent years (UNEP, 2004).

11.2 Frequency and amplitude of water related disasters

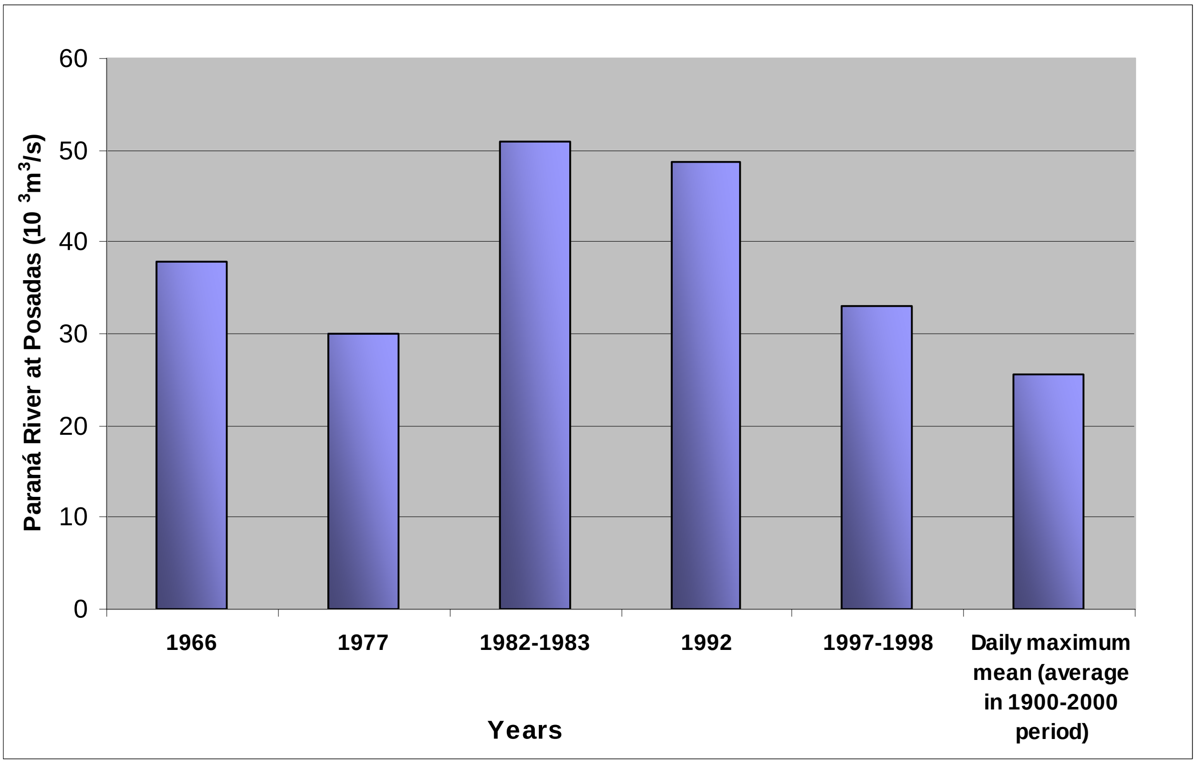
- Floods

Flooding is the major risk of natural origin in the La Plata Basin. Floods are triggered by three main factors: natural increase in water levels over their banks in rainy seasons, disorganised urban sprawl and increased groundwater table levels (Tucci, 2004).

Riparian Floods: In the Paraguay River Basin and in the lower stretch of the Paraná River, floods are caused by long raining periods that affect vast areas, producing high water levels for many months. In the Argentinean stretch of the Paraná River, the relief is flat and it normally remains flooded for several months. In the upper stretch of the Paraná and Uruguay rivers, floods are quick, lasting only a few days (Tucci, 2004).

Since 1970, floods became more frequent, taking place every four years on average. The Paraná River water flow increased two or three times above the average flow (Figure 11.1) in each El Niño event. The greatest frequency has been associated with the El Niño phenomenon and the impact of land use in the upper Paraná Basin. The need for land zoning of risk areas and implementation of preventive measures to control flooding becomes evident (Tucci, 2004).

Figure 11.1. La Plata River Basin. Paraná River flow at Posadas during El Niño events



Source: UNEP, 2004; SSRH, 2000

The *Centro de Alerta Hidrológica* (Hydrological Warning Centre), which has been operating in Argentina since the devastating floods of 1982-83 (during El Niño event), reports that the average length of the floods occurred in 1987-1998, has been between 7 and 40 days (Crespo Milliet, 2004).

Between 1959 and 1982 the Iguaçu River in União da Victoria (Brazil) registered only one flood with a returning period of over 5 years. Coincidentally, during this period, Brazilian cities underwent their biggest economic growth and expansion. Flooding after 1982 caused significant damage to the community (Tucci, 2004).

In the Pantanal (Upper Paraguay River), man and the environment coexist in harmony. A marked difference has been noticed in Ladario between the 1960s and the previous and subsequent periods. During this time, populations settled on the floodplains, taking the area over for livestock raising. In the following period, the floods struck again, and the settlers were displaced because of the rising frequency of high flows. Two immediate consequences were the loss of value of real estate and the inability of the inhabitants to make a living. As a result, the settlers moved to the periphery of the cities in the region (Tucci, 2004).

Urban floods: A great number of cities whose population exceeds 20,000 inhabitants suffer - in a way or other- the effects of flooding due to urbanisation. This is the result of a totally inadequate urban drainage management policy, which tends to favour drain-off and not retention. The urban development and the soil waterproofing (due to households, roads, sidewalks and others), has reduced the underground drainage and the volume that does not infiltrate, flows along the streets and storm drains. This process has created an increase in the flood flow rate, which has risen as much as sevenfold compared with past flow rates. This can be observed in recorded values for Curitiba Metropolitan Area, for example (Tucci, 2004).

In the Paraná River and its tributaries, there are several densely populated cities, which are quite frequently flooded. In this area, floods are quite frequent due to inadequate urban drainage. Again, this kind of floods is associated with soil waterproofing and urban river canalising. In practice, this results in flow peaks seven times higher than those observed in natural conditions. In the Upper Paraná region, the most affected cities are those located on the banks of the Iguaçu River (União da Vitória, Porto União and Curitiba) and the Tietê River (São Paulo) (Tucci, 2004).

In Argentina, floods seriously affect the major riparian urban centres of the La Plata River (Buenos Aires Metropolitan Area) and the Paraná River (Resistencia, Corrientes), as well as other cities such as Santa Fe, which suffered the country's worst-ever flood in April-May 2003. Floods in the Litoral are strongly influenced by El Niño events and the most severe occurred in 1982-83, 1992-93 and 1997-98 (Mugetti, 2004).

In Buenos Aires Metropolitan Area floods occur in the basins of the two most important tributaries of the La Plata River sub-basin (Reconquista and Matanza-Riachuelo rivers) and in the Autonomous City of Buenos Aires, where the problem is associated with the overflow of canalised streams as a consequence of convective rains. In both cases, another flood triggering factor is the increased water levels of the La Plata River (due to stormy Southeast winds or ocean waves, a phenomenon know as "sudestada").

Increases in water table: In the last few years, increases in water table levels have been observed in the Pampean region, which are associated with natural and anthropic factors. In urban and suburban areas, water table levels cause problems in the underground infrastructure and increase the potential contamination of groundwater. In rural areas, the shallow depths and the upwelling of waters provoke floods in vast areas devoted to agriculture and livestock activities. Although this problem is associated with natural causes (mainly, the increase in rainfall after the 1970's), there are other anthropic causes such as: the reduction of groundwater pumping (by water supply service companies, by the industrial sector and other users), the construction of infrastructure works that obstruct the circulation of superficial water favouring the recharge the aquifer; the increase in infiltration of irrigation water; the inadequate territorial zoning (UNEP, 2004).

- Low water levels

Long periods of low water levels may become a factor of economic and social imbalance in the basin. Historical data show that many populations had to leave the area due to long drought periods. The last 30 years show that the region is going through a spell of favourable weather although there have been considerable low water levels in the past.

In general, the basin does not have significant water deficiencies. Some low water levels impact on the major urban centres and they are related to supply for human consumption. This happens because some major urban centres are located in the headwaters of the tributaries of main rivers, which limits the availability of resources, adding to the low quality of the water due to contamination. São Paulo and Curitiba cities epitomise this scenario (Barros *et al*., 2004).

The Paraná River had a dry period between 1952 and 1956, considered critic to hydroelectric generation in Brazil. However, the period between 1930 and 1970 was drier than the following one. As most of the energy, water supply, navigation and other infrastructures were sized based on the more recent natural rainfall and flow rate-related drivers, the potential risk of a dry spell –and its resulting impacts on society– continues to exist, and might occur in the future (Tucci, 2004).

The Paraguay River had very low water levels between 1960 and 1973, much lower vis-à-vis the century's previous and subsequent periods. Minimum levels followed the same trend and the Pantanal mean water levels remained around 2 m below those observed in previous periods. Although these periods rendered its benefits as it enabled the use of vast areas previously flooded, the permanent flooding area of the Pantanal was reduced, which altered its environmental conditions. The impact of lower humidity could eventually turn marshlands into savannahs (Tucci, 2004).

Several historical series of the Uruguay River reveal that between 1942 and 1951 rainfall was far below the mean. As this area produces most of the agricultural products in the region, the occurrence of a dry period such as the one just mentioned might lead to a variety of impacts, e.g., a significant rural GDP reduction in the countries of the basin. Since most available historical series are more recent, it may be inferred that this basin's infrastructure is undersized and subject to heavy failure risk factors, so that the region's economy and development are seriously jeopardised (Tucci, 2004).

11.2.1. Economic and social consequences of major water-related disasters

After several big-scale disasters, the *Comisión Económica para América Latina y el Caribe*, CEPAL (Economic Commission for Latin America and the Caribbean), the World Bank and other regional and international institutions have carried out exhaustive economic loss appraisals. However, these studies are like snapshots and they do not capture the general outlook of accumulated economic losses at national and international scale. Meanwhile, the effects of disasters on livelihoods and the weakness they produce on the social capital may be inadequately assessed. Particularly, due to the lack of data, some slowly-appearing disasters or those without major consequences may have been deemed less important, although they lead to failure in local development, collapse of households and poverty (PNUD, 2004).

Some countries rely on national databases with detailed information about losses caused by disasters. However, they still do not have global or regional coverage. Moreover, national databases show deficiencies that are similar to those of global databases concerning information about economic losses and deterioration of livelihoods (PNUD, 2004).

With regard to the La Plata Basin, the outlook described above is repeated: there is no systematic record of accumulated losses along time, but partial and isolated data of each major disaster. Flooding is a significant problem that involves the loss of human lives and considerable damage to the infrastructure and the economy due to the severity, periodicity and permanence in time of these disasters, particularly in the sub-basins of the Paraná, Uruguay and Lower Paraguay rivers (Crespo Milliet, 2004).

The common impact scenario in the basin is the human occupation of floodplains for a number of years when annual maximum levels are low. Plain areas are favourable for settling. When periods of more frequent flooding return, damages are significant and the population demands that the government should take action by building control structures such as dams, among others (Tucci, 2004).

Regarding major impacts, it is observed that the risk to human health increases, particularly in relation to tropical and water-related diseases. Climate change increases the feasibility of certain disease vectors and the propagation of existing ones. Extremes in the hydrological cycle, such as water shortage and flooding, could increase the risk of diarrhoea. Water shortages cause diarrhoea due to poor hygiene, and flooding can pollute drinking water due to watershed runoff or sewage overflow (UNEP, 2004).

There is good evidence that the El Niño Southern Oscillation (ENSO) cycle is associated with increased risk of certain diseases and can affect distribution, reproduction and mortality of disease vectors. Several studies have speculated that the cholera outbreak in the early 1990s was linked with the 1992-1993 El Niño events (UNEP, 2004).

There follows a brief description of major social and economic impacts in each of the four main sub basins: Paraná River, Paraguay River, Uruguay River and La Plata River.

- Paraná River

In most cities of the La Plata Basin region in Brazil, occupation of the flooding risk areas took place during the economic development period, between the 1960's and early 1980's, when these critical events became more frequent (Dias Coelho, 2004).

In the region, flooding in urban areas is common as a result of soil waterproofing and the canalisation of urban rivers, as is the case of the Tietê River Basin (São Paulo Metropolitan

Area) and the Iguaçu River Basin (Curitiba Metropolitan Area). In the rural area, flooding is caused by the occupation of floodplains. In both areas floods cause significant economic damage, usually linked to alterations of the natural hydrological behaviour and the land use and occupation with no prior planning (Dias Coelho, 2004).

In Argentina, direct and intangible damages caused by floods associated with ENSO events were estimated at 2,640 million dollars, meanwhile 235,000 people were evacuated. In the Brazilian State of Santa Catarina, the same flood event of the Paraná River caused losses amounting to 8% of the State's annual GDP. Meanwhile, the accumulated loss due to the floods between 1983 and 1993 in União da Vitória on the Iguaçu River banks was over US$ 110 million. (Dias Coelho, 2004).

Table 11.1 shows detailed data of the losses caused by the five major floods in the Northeast of Argentina (1966, 1977, 1982-83, 1992-93 and 1997-98).

Table 11.1. La Plata River Basin. Socioeconomic impacts of major El Niño events in the northeast of Argentina

Year	Paraná River at Posadas (daily maximum mean discharge (m^3/s)	Affected surface (millions of ha)	Economic loss (millions US$)	Number of affected people
1966	37,885	n/d	751	n/d
1977	30,081	n/d	265	n/d
1982-1983	50,882	4.0	1,790	177,035
1992	48,790	3.0	905	133,106
1997-1998	33,000	18.5	17,502	121,348

n/d: no data
Source: UNEP, 2004.

Argentina devotes more than 80% of its territory to farming, ranching and forest activities, putting strong pressure on natural resources, particularly the soil. This situation is particularly critical in arid and semiarid zones, which account for 75% of the national territory, where the loss of agricultural productivity causes direct socioeconomic impacts. In the La Plata Basin, these arid conditions are seen in the Gran Chaco region, where the non-sustainable farming and ranching use has generated erosive processes and loss of soil fertility. This scenario worsens towards the West, where the Arid Chaco region shows the most extreme aridity conditions and a process of desertification (Tucci, 2004).

- Paraguay River

The Paraguay River has vast floodplains and a slow runoff regime. Since inhabitation of the Upper Paraguay Basin is relatively low, impact of floods is not as catastrophic as it is in its lower course, where several cities are affected, such the capital city, Asunción (Monte Domecq, 2004).

As in the whole region, El Niño sparks significant processes of high waters and flooding. In Paraguay, the consequences of El Niño were substantial in 1982-1983, since flooding was registered all along the Paraguay River, starting at the Pantanal. In El Niño 1992-1993, high waters were registered from the City of Concepción towards downstream (Gamarra Lovera, 2002).

Within the Bolivian territory, the major impact of variability and climate change on society is basically related to the economic aspect. With a population principally devoted to agriculture and livestock activities, most under low productivity and subsistence conditions, the effects of adverse phenomena such as droughts or hail are devastating, mainly considering the poor capacity to invest in support infrastructure. In this context, the producer's strategy tends to favour survival instead of maximizing the benefit. This translates into reduction in the production, less cultivated area, less livestock, more variety of small-scale cultivations and the resulting lower trading capacity (Crespo Milliet, 2004).

- Uruguay River

The Uruguay River has also shown substantial impacts due to flooding, mainly in its middle and lower stretches in the cities of São Borja (Brazil), Santo Tomé (Argentina) Itaqui, Alegrete, Uruguaiana (Brazil) and Paso de los Libres (Argentina). Between 2000 and 2004 all 19 departments have been affected by some kind of flooding, the most significant being Artigas, Tacuarembó, Cerro Largo, Durazno and Paysandú (Tucci, 2004).

Flooding also causes serious damage in riparian cities and it affects economic activities in the Uruguay River Basin. The geographical location of most cities, i.e., near rivers and streams, make them vulnerable to being affected by increasingly frequent floods, mainly due to an increase in extreme precipitation events (Von Cappeln *et al.*, 2002).

The greatest flood occurred in 1959, when 38,000 people were evacuated in the centre and west areas of the country; damages were estimated at US$ 39,000,000 (at those times exchange rates). Closer in time, the flood of August 1986 affected the southern and eastern departments and 16,000 people were evacuated in the Santa Lucía River Basin, leaving 2,300 people homeless.

During the El Niño event of 1983-84 in the Middle Uruguay, over 40,000 people were affected in more than 70 cities; losses caused by this event in the entire La Plata Basin were estimated to have exceeded 1 billion dollars (Crespo Milliet, 2004). In June 1992, a 37,714 m^3/s inflow to the reservoir of the Salto Grande binational dam (Argentina-Uruguay) was recorded, which turned out to be the maximum water discharge ever recorded in the region since 1898 (von Cappeln *et al.*, 2002).

Droughts in Uruguay greatly affect productive agriculture-livestock activities, decrease hydroelectric generation, put water supply for human consumption or populations in jeopardy, damage flora and fauna natural ecosystems, etc. In the last 100 years, Uruguay suffered long drought periods, such as those occurred in 1891-94, 1916-17, 1942-43, 1964-65 and 1988-89. There is no systematic data collection regarding the characteristics of the droughts, their consequences and effects. Qualitative information is available only to report that some basins are hit harder than others. For instance, the drought of 1988-89 affected the Negro River and Santa Lucía River Basins more intensely than other basins of the country (von Cappeln *et al.*, 2002).

Urban droughts in Uruguay may be considered a priority problem, not so much judging by its characteristics in terms of figures as compared to other world or regional events, but based on their impact on local economies and social-cultural development. Within a context of weakness of the Government and worsening of economic crises, impacts become more serious, particularly in cities and regions of lower relative economic development.

As regards social structures of affected populations, there is no rigorous and systematic data collection. There is a wide diversity of situations that should necessarily be taken into account when action strategies are planned. However, studies carried out in various towns have determined that the most seriously affected social sectors are poor populations. The most critical cases coincide with processes of informal settlements on public lands in the banks of streams and rivers. In many cases, work opportunities are directly connected with the river, such as extractive activities (sand-mining and brick-making in Artigas and Paysandú cities) and solid waste classification, as occurs in Montevideo (von Cappeln *et al.*, 2002).

The population settled in legal lots authorised by local governments –case of Artigas–, in spite of being against the criteria of laws in force and municipal ordinances as well. These sectors of "formal" city are lots that were consolidated by mid XX century as a result of rural-urban migration; in some cases they are historical neighbourhoods undergoing a process of decay –case of Paysandú– (von Cappeln *et al.*, 2002).

- La Plata River system

Buenos Aires Metropolitan Area is located in the lower part of several basins, which drain their waters down to the La Plata River (Riachuelo-Matanza, Reconquista, Maldonado, and Medrano). Constructions and pavements are covering increasingly greater surfaces, which is not consistent with the available capacity of storm drains to response to severe storms that occur more and more frequently in the metropolitan area. Therefore, when there is a significant storm, the existing storm drain system collapses, which has a strong impact on the population, their belongings and the existing infrastructure (Gentile & González, 2001).

One of the heaviest storms was registered on May 31st, 1985. The rain rate amounted to 308.5 mm in 25 hours (45.5 mm/hour). Such colossal storm caused catastrophic consequences due to floods in Buenos Aires City and its metropolitan area. A death caused by electrocution was reported; the event affected 630,000 neighbours, left 150,000 telephone lines out of order and affected gas supply; the subway system was completely interrupted and most of the railways too; the traffic light system was greatly affected, 68 high tension feeders were left out of order and all kinds of inconveniences were seen in the transportation system and the access to the city (Gentile & González, 2001).

Other considerable storms that flooded the City of Buenos Aires were on March 15th, 1994 (rainfall intensity of 46.4 mm/h), February 6th, 1998 (40 mm/15^{m}) and January 24th, 2001 (82.7 mm/h). In all these cases, the consequences were similar to May 1985: the city was paralysed. The most severe floods due to increased water levels of the La Plata River are those occurred on April 15th, 1940 (4.45 m above the reference water level of the Riachuelo River), following, in order of importance the flood of November 12th, 1989 (4.06 m), February 7th, 1993 (3.95 m) and July 27th, 1958 (3.85 m) (Gentile & González, 2001).

11.3. Management tools against extreme events

On the whole, it is observed that measures taken to cope with extreme hydrological events are too biased towards structural measures while cases where non-structural measures are effectively implemented are very few. Among the latter it is worth mentioning the warning system as the greatest preventive measure.

Another outstanding characteristic in the basin is that there is practically no link between territorial zoning (in the shape of urban planning and basin management) and extreme event management, which usually results in impacts being worse. The same happens with measures that are taken in critical moments (when the event occurs) or that are not completed, which increases the disastrous characteristics of floods and droughts.

There are a few cases to illustrate the above mentioned. In the cities by the Argentine stretch of the Paraná River, which are protected against riverside floods (e.g., dikes), the urbanisation process has compromised such protection, since the waterproofing of the sub-basins within the dikes, threaten flooding control and critical event management, as was the case of Santa Fe in 2003 (Tucci, 2004).

On the other hand, since 1990, works have been carried out to minimise flooding within riverside protecting dikes in the cities of Posadas, Resistencia, Corrientes, Paraná, Santa Fe and Rosario. However, the lack of urban planning and the use of canalisations worsen existing problems. After the 11-month flood of 1982-83 in the area of Resistencia City, protection within the city's territory was built, what rendered it more vulnerable to internal rainy floods due to urbanisation. In 1998, the regulation of land use was drawn up, based on the risk of combined rain occurrence in the city and in the Negro River (affluent of the Paraná River near Resistencia). The city relies on the storage capacity of 29 lagoons and pumping capacity (Tucci, 2004).

A diversity of historical series of water levels in the Uruguay River shows that between 1942 and 1951 rainfalls were below the mean. Considering that most available historical series are recent, it may be inferred that the infrastructure of the basin is insufficient and subjected to strong risks of failure, what leaves the region at the mercy of impacts on its economic development (Tucci, 2004).

11.3.1. Risk-management in the La Plata Basin

As stated before, there is no integrated risk management in the basin, including all the dimensions (physical-natural and socioeconomic-political) and the "phases" of the disaster[54]. Neither is there integration between the territorial zoning and disaster management.

Recently, the *Programa de las Naciones Unidas para el Desarrollo,* PNUD (United Nations Development Programme) has carried out activities to create a risk index that contemplates the integration of physical-natural and socioeconomic components of risk. The concept underlying the IRD, *Índice de Riesgo de Desastre* (Disaster Risk Index) is that the risk of disaster is not caused by natural threats *per se.* It is also a result of human intervention. Thus, the risk of death in the context of a disaster depends only partly on natural phenomena such as

[54] These phases are: mitigation, prevention, preparation, response and rehabilitation.

earthquakes, tropical cyclones or floods. Due to the lack of international databases (with national resolution), the IRD refers exclusively to the risk of death and it does not comprise any other aspects, such as damages to livelihoods and the economy (PNUD, 2004).

By definition, for an intense physical phenomenon to be considered dangerous, there must be an individual who experiences the hazard or threat. An example to illustrate this would be those individuals, infrastructures and economic activities within the action radius of an earthquake. In the IRD, this relationship is expressed with the concept "physical exposure", which refers to the number of people within threatened areas and the frequency of hazardous events. Physical exposure is not an indicator of vulnerability but a *sine qua non* condition to determine that the risk of disaster exists. If there are no individuals exposed to danger, human life does not run any risks (PNUD, 2004).

Greater physical exposure brings about a greater amount of deaths. If a population exposed to flooding is quintupled and no changes take place in other developmental aspects, mortality caused by such events would also be five times greater. A typical characteristic of the development process is a very high physical exposure, which can be verified in many countries because of the dense demographic concentration in areas exposed to threats (PNUD, 2004).

However, physical exposure is not enough to explain the risk. The degrees of risk may differ greatly from country to country with similar physical exposure to a certain hazard. *Vulnerability* is what explains why people, given a certain degree of physical exposure, face more or less risk. In theory, vulnerability varies according to the survival and adaptation capacity. In the IRD, survival and adaptation capacity are supposed to have influenced the degree of risk detected. Vulnerability conveys, in only one concept, all these elements related to human processes (PNUD, 2004).

In the IRD, vulnerability comprises the multiple factors that affect individuals and prevent them from absorbing the shock and recover after the impact of a hazardous event. These factors may be economic (lack of reserves or scarcity of goods), social (lack of social assistance mechanisms or an inadequate social organisation), technical (unsafe households of poor construction quality) and environmental (fragility of ecosystems) (PNUD, 2004).

According to the meaning conveyed by the term vulnerability in the IRD, it also includes factors that may increase the severity, frequency, magnitude and unpredictability of a threat. For instance, deforestation could make floods more severe and increase the threat of landslide in certain contexts and, the destruction of coastal mangrove swamps may contribute to hazards associated with cyclones. Thus, the term vulnerability of IRD comprises both development activities that impact on threats and those that impact on human vulnerability (PNUD, 2004).

The category "vulnerability" of the IRD also includes those factors that may reduce vulnerability, such as adequate urban development and planning and special activities aimed at mitigating losses caused by disasters, e.g., preparation for disasters and early warning systems (PNUD, 2004).

The definition of IRD is based on the grounds that factors that make people vulnerable to earthquakes are not necessarily those that make them vulnerable to floods or cyclones. All of them correspond to a certain combination of developmental activities. Given the fact that vulnerability varies according to the threat that is being faced, it is impossible from the conceptual point of view, to come up with a combined vulnerability indicator that includes different kinds of threats. Therefore, the vulnerability indicators proposed by IRD are always case-specific (PNUD, 2004).

11.3.2. Tools and instruments for calculating risk

Information referring to this section has not been found either, in addition to what was dealt with in the previous section in connection with the IRD developed by the PNUD (2004). The experimental IRD is used for measuring and comparing the relative levels of physical exposure to the threat, the vulnerability and the risks between countries, and also to identify vulnerability indicators. Four different types of natural threats were examined (tropical cyclones, earthquakes, floods and droughts) which are responsible for 94% of the deaths caused by natural disasters. Likewise, the exposed population and the relative vulnerability of all countries to each of these catastrophes were calculated (PNUD, 2004).

The combined IRD model is based on the socioeconomic variables associated with each particular threat. The combined IRD moves away from the risk analysis, which is centred in the threats and adopts an innovative approach that consists in analyzing the risks, based on the vulnerability factors (PNUD, 2004).

The fundamental steps that were taken to define the IRD were the following:

Calculation of the degree of physical exposure: To calculate physical exposure in each country, the areas exposed to each kind of threat (earthquakes, tropical cyclones, floods and droughts) and the number of inhabitants in each area –annual average of population exposed to a certain threat– were determined. The map of physical exposure to each threat was loaded into a Geographical Information System, GIS. Physical exposure varies depending on the number of individuals and the frequency of hazardous phenomena. In the IRD, physical exposure is expressed in absolute terms (number of individuals exposed per country) and relative terms (number of individuals exposed per million inhabitants).

Calculation of relative vulnerability: The risk of death in natural disasters depends on the physical exposure and vulnerability to the threat. Individuals are relatively vulnerable to a certain kind of threat according to various factors: social, economic, cultural, political and physical. To represent the *manifest risk* in the IRD, the death toll for each type of threat country by country was considered. In other words, by definition, past disasters indicate that there were physical exposure and vulnerability conditions. Therefore, dividing the number of casualties by the number of individuals exposed, the IRD was able to calculate the relative vulnerability of a country to a certain threat. That is to say, the more individuals killed in proportion to individuals exposed, the greater the relative vulnerability to the threat involved (PNUD, 2004).

Calculation of vulnerability indicators: The IRD later analysed the evident risk of each type of threat and it was compared with a series of social, economic and environmental indicators, analysing it statistically with a multiple regression logarithmic model. For each kind of threat, specialists selected 26 variables, for which global data was available, and they were later analysed. Such variables made it possible to select the vulnerability indicators that where more closely related to the risk associated with each type of threat (PNUD, 2004).

The results of the application of this index to floods indicate that an approximate annual average of 196 million individuals in more than 90 countries is exposed to catastrophic floods. It is estimated that the period between 1980 and 2000, some 170,010 people died in floods worldwide[55].

As in the case of earthquakes and cyclones, there is a close relationship with *physical exposure*. In floods, this variable is related to the *per capita* GDP, which is in turn inversely proportional to the number of casualties. Likewise, a negative correlation between casualties in floods and *local demographic density* was identified. The countries with greater risks associated with floods were those with a low *per capita* GDP, low population density and a significant number of individuals exposed (PNUD, 2004). Table 11.2 shows the major characteristics of floods in four of the five countries of the La Plata Basin.

Table 11.2. La Plata River Basin. Impacts of floods by country (except Uruguay)

Countries	Average number of events per year	Number of people killed per year	Average number of people killed per million inhabits	Average physical exposure per year	Physical exposure (in % of population	Relative vulnerability (killed per million exposed)	Density of people (living in watershed exposed)
Argentina	1.19	17.14	0.84	7,434,608	22.71	1.58	26.78
Bolivia	0.48	14.48	2.25	3,035,231	47.57	4.77	6.63
Brazil	2.19	99.33	0.97	18,304,697	12.33	5.43	26.78
Paraguay	0.38	3.62	0.85	1,494,319	35.06	2.42	10.00

Source: PNUD, 2004.

11.4. Measures against disasters in the La Plata Basin

In the following items, a detailed description of structural and non structural measures taken by the countries of the basin to cope with disaster will be provided. In this section reference will be made to the fact that, despite the severity of the impacts of extreme events (especially floods) there have been few successful experiences with a certain degree of continuity along time. There has not been a joint, integral and integrated strategy among the five countries of the Basin to prevent, respond to and/or recover from floods. There are numerous subsisting gaps and problems regarding disaster handling, the causes of which have been summarised in Figure 11.2.

The different colours in Figure 11.2 indicate that the causes are shared by two or more countries or, in some cases, if they are detected only in one country. As Figure shows, most of the causes are identified in two of the five countries.

[55] It was estimated that 147 countries have populations potentially threatened by flooding. Densely populated Asian countries rank first (India, Bangladesh, Pakistan and China), both in absolute and relative terms. This is explained by the huge population that live in the vast plains near the rivers that are frequently flooded and the low-lying coastlines in this part of the world. As far as the social situation is concerned, Venezuela comes in first place, with the greatest relative human vulnerability to flooding, based on the number of casualties that these disasters left, as a consequence of a single exceptional phenomenon occurred in 1999 (PNUD, 1999).

11.4.1 Structural measures against disasters

Flood control is one of the multiple uses offered by large dams. In the Argentinean sector of the basin there are 8 dams, the aim of which is flood regulation, among others. These dams are:

- Yacyretá (on the Paraná River, shared by Argentina and Paraguay);
- Cabra Corral (on the Juramento River, province of Salta);
- El Tunal (on the Juramento River, province of Salta);
- Río Tercero (on the Tercero River, province of Córdoba);
- Arroyo Ludueña (on the Ludueña stream, province of Santa Fe);
- Ingeniero Roggero (on the Reconquista River, province of Buenos Aires);
- Piedra Blanca (lateral closure, on the Quinto River, province of San Luis); and
- Paso de las Carretas (on the Quinto River, province of San Luis).

In Brazil, until 1979 (when floods in the San Francisco River Basin and the Southeast of the country occurred) there were no procedures to combine hydroelectric uses and flow regulation, because of the adoption of water storage volumes in the reservoirs of hydroelectric power plants (Dias Coelho, 2004).

However, the huge existing systems have not a coordinate system of forecast and warning to protect riverside populations from floods. This is getting worst due to denser occupation of the riverside areas downstream the reservoirs. Even in this scenario, Brazil has no preventive measures in case of breaks of dams –such as risk analysis–, which would be fundamental for the Paraná Basin, considering that this basin has numerous dams, many of which are cascading (Dias Coelho, 2004).

Among the structural measures adopted by Uruguay, the most significant are the reservoirs of hydroelectric dams that enable control of water levels downstream. Thus, dams contribute to the “meteorological warning” and an eventual evacuation could be done in stages avoiding “night flooding” and diminishing maximum heights above river level. These are the cases of cities of Salto and Paysandú with Salto Grande dam, Paso de los Toros with Rincón del Bonete dam and the City of Mercedes with the Rincón del Bonete and Palmar dams (Genta *et al.*, 2004).

In 1997 and 1998 the *Administración Nacional de Usinas y Transmisiones Eléctricas*, UTE (National Administration of Power Stations and Electric Transmissions) updated hydrological studies for three dams on the Negro River –Dr. Gabriel Terra, Rincón de Baygorria and Constitución–. Their discharge capacity was reassessed according to the maximum flows and the structural safety of the works of main dams and their auxiliary ones undergoing extreme high waters situations in relation to hydrological and hydraulic results obtained. Through these studies, UTE drew up a program for the operation of spillway gates to laminate extreme flooding, maintaining structural safety conditions. Finally, flooding maps were made, spotting affected areas downstream of the three dams for cases of normal, extreme and extraordinary flooding. Besides, recommendations were provided to be taken into account in contingency plans (Genta *et al.*, 2004).

Figure 11.2. La Plata River Basin. Hydrological Extremes, floods and droughts, water excess and deficit
Floods: Apa, Iguazú, Paraguay, Pilcomayo, Bermejo, Paraná and Uruguay (Cuareim)
Droughts: the entire basin

Source: Lanna, 2004

Based on these documentation, a contingency action plan is being developed, which comprises the drawing up of a self-contained single document, which includes all the activities to be carried out by the UTE in case of water emergencies in hydraulic generating installations (dams, hydroelectric generating stations, auxiliary dikes). The scope of this plan is in principle limited to actions to be taken towards safeguarding effects and individuals linked to hydraulic generating installations, although it may contain general recommendations outside this field (Genta *et al.*, 2004).

The *Transboundary Diagnostic Analysis* (TDA) carried out within the *Programa Marco para la Cuenca del Plata* (Framework Programme for the La Plata Basin), pointed out various critical factors in dam management and operation and suggested actions to mitigate existing problems. Such factors and actions are summarised in Table 11.3.

Table 11.3. La Plata River Basin. Critical transboundary issues related to environmental, economic and social vulnerability in disastrous events and catastrophes of different origins.

Critical transboundary issue	Causes of vulnerability	Suggested actions for mitigating vulnerability
Dams: Safety and emergency plans.	• Risk of breaks due to operating errors; • Lack of contingency plans for the potentially affected river reach; • Lack of common regulations to operate in emergency conditions and dam safety; • No review of dam safety criteria, considering the incidence of climate change; • Lack of transboundary contingency plans; • Poor communication and coordination among countries to provide information about existing dams upstream of potentially affected countries.	• Set forth dam operation regulations and criteria by means of agreements among countries; • Incorporate climate variability to reservoir operation and hydrological warning; • Adopt common regulations to operate reactively in emergency and dam safety conditions (realise the *Planes de Acción de Emergencia* PADE - Emergency Action Plans, and *Planes de Seguridad de Grandes Presas* – PSP - Safety Plan for Large Dams); • Exchange information about conservation methods, safety of works and operation of the basin's reservoirs; • Adopt common dam safety criteria considering the incidence of climate change.

Source: Lanna, 2004

Apart from dams, there are other structural measures that are commonly adopted both to respond to and to prevent flooding such as embankments and coastal defences. In previous sections, reference was made to defences built in the Northeast of Argentina on the occasion of the significant floods triggered by the ENSO phenomenon in 1982 and 1983 (City of Resistencia, Province of Chaco). However, many times, building defences may increase the risk, as was the case of Resistencia, where defences impeded discharge of excess pluvial flows from the *interior* of the city. On other occasions, unfinished constructions may increase the risk, e.g. the flood in City of Santa Fe (Argentina) in April-May, 2003.

11.4.2. Non-structural measures against disasters

All countries already have or are gathering efforts to run institutions in charge of determining warnings based on data provided by the meteorology and hydrology services either at a regional or national level: *Defensa Civil* (Civil Defence) in Brazil and Argentina, *Comité de Emergencia Nacional*, CEN (National Emergency Committee) in Paraguay, *Sistema Nacional de Emergencias*, SNE (National Emergency System) in Uruguay.

With regard to meteorological and extreme hydrological events prediction, Brazil shows an advantage in terms of forecasting, since the country has the capacity to predict intense rainfall events. Based on these products, operational meteorology centres in Brazil, civil defence secretariats of the states and the capital city determine hydrological warnings, based on criteria which vary from state to state. Taking the particular case of the City of São Paulo, there is a high advanced hydrological warning system for the capital city only. This system employs trained staff, relies on advanced models, rain observations through radar and a hydrometeorological telemetric network, which emits warnings (Marengo *et al.*, 2004)..

In Argentina, the advantage is seen in the existence of the *Sistema de Alerta Hidrológico de la Cuenca del Plata* (La Plata Basin Hydrological Warning System), managed by the *Instituto Nacional del Agua,* INA (National Institute of Water). This system was born during the 1982-83 ENSO event, and works for the Argentinean part of the La Plata Basin. The Warning System has had significant advances in forecasting and improved the responses during the floods produced since its creation. It also predicts water levels, which is important to plan navigation and harbour activities. The Warning System has got equipment and instruments of high technology, which enhance the information exchange in real time with the provinces and other national institutions (INA, 2005).

In Uruguay, the national legal framework attributes jurisdiction to municipal governments to determine land qualification for prospective urbanisation. In this sense the Municipal Organic Law 9,515 of 1935, and the *Ley de Centros Poblados* (Populated Centres Law) 10,866 of 1946 and amendments provide that division into lots of “non suitable” areas is impeded by virtue of their floodable characteristics. As regards local legal frameworks, each city has approached this issue autonomously, drawing up ordinances and in some cases, Land Plans, which provide for this issue. However, these instruments, as well as national laws are not enforced in most cases (Genta *et al.*, 2004).

One of the weaknesses of the basin is regarding overall severe atmospheric phenomena considered. It is common the lack of data collection on extreme rainfall events and what is even more fundamental, the lack of common criteria to define what should be considered an extreme rainfall event or the definition of maximum discharge values or river water levels that could bring about intense flooding which represent an extreme hydrological event. This last point is important, since –according to the criteria of mayors of big cities, hydroelectric system operators and the agricultural sector–, the definition of extreme hydrological events varies. It also varies from country to country, which makes it difficult to draw comparisons and promote integration in the whole basin. There is also a lack of small-scale early warnings for vulnerable cities, such as São Paulo or Buenos Aires. The deterioration of existing warning systems and cultural deficiencies make difficult to handle this issue (Marengo *et al.*, 2004).

As in the case of structural measures, the above mentioned Transboundary Diagnostic Analysis (TDA) has detected flaws regarding non-structural measures and possible actions to be taken to overcome these difficulties. Table 11.4 displays this information.

Table 11.4. La Plata River Basin. Critical transboundary issues related to environmental, economic and social vulnerability in disastrous events and catastrophes of different origins

Critical transboundary issue	Causes of vulnerability	Suggested actions for mitigating vulnerability
Hydrological extremes, floods and droughts, water surplus and deficit	• Inadequate monitoring systems, hydrometeorological prediction and insufficient investigation on extreme events; • Lack of definition of risk areas; • Lack of operating capacity for management and dissemination of territorial planning connected with extreme events. • Lack of regional economic criteria for managing extreme events.	• Generation and financing of lines of investigation; • Adaptation (expansion and strengthening) of hydrometeorological monitoring networks, standardise parameters and exchange originated data; • Adoption and operation of an integrated warning system; • Institutional strengthening of national and local agencies by means of training, allocation of resources and tools to implement policies for territorial planning and integrated management of water resources in the region; • Implementation of transboundary programs for an integrated water resources management considering inter-institutional operating aspects and their sustainability; • Water and climate studies

Source: Lanna, 2004

The same TDA document shows information gaps in terms of prospective actions to be taken concerning hydrological extremes. These gaps are shown in Table 11.5.

Table 11.5. La Plata River Basin. Identified information gaps of prospective actions

Actions		Information Gaps
Adjustment of hydrometeorological monitoring networks, standardisation of parameters and data exchange	Institutional strengthening of national and local agencies by means of training, allocation of resources and tools to implement policies for territorial	Standardisation of hydrometeorological practices
Expansion and		Transboundary information and management systems

Actions		Information Gaps
strengthening of the hydrometeorological networks and interchange generated data	planning and integrated water resources management in the region	Joint topographic/bathymetric studies
		Shared cartographic base (SIG)
Hydrological and climate studies	Implementation of environmental education programmes which include all social and governmental levels (regional, national, local)	Climate and hydrological forecast models applied to extreme hydrological events
Identification and analysis of an integrated warning system		
Implementation of databases integrated at basin level into information systems to contribute to decision-making	Coordinated management of large reservoirs	Contingency plans to mitigate the effects of extreme events (droughts and/or flooding)
	Feasibility studies on water transfer between basins	
Implementation of transboundary programs for integrated water resources management considering inter-institutional operating aspects and their sustainability	Coordination for supervising fulfilment	
	Encouragement of citizens and users' participation by making public calls for the presentation of projects related to extreme hydrological phenomena	
	Generation and financing of lines of investigation	

Source: Lanna, 2004

11.4.3. Responding to disasters

In this section information was gathered in connection with national institutions in charge of responding to disasters and of existing and/or projected plans.

11.4.3.1. Argentina

The Argentine institutions with direct responsibility in responding to emergencies are the *Dirección Nacional de Protección Civil,* DNCP (National Directorate of Civil Protection) and the *Sistema Federal de Emergencias,* SIFEM (Federal Emergency System), within the

Ministerio del Interior (Ministry of Internal Affairs). In emergency situations, the SIFEM is empowered to summon and work interactively with multiple institutions of the national organisation chart, which are called *Organismos de Base del SIFEM* (SIFEM's Base Institutions).

The Civil Protection has a long tradition in the country. However, successive changes from ministry to ministry since 1996 have not allowed this institution to consolidate the development of programs and projects. Since the beginning of the 2000s it is understaffed and has a reduced budget appropriation.

Within the SIFEM is the *Centro Nacional de Emergencias*, CENAE (National Emergency Centre), whose mission is to carry out plans and activities in order to employ human and material resources from the institutions they represent as effectively as possible, as a contribution to the federal support to face disasters of any kind. Likewise, the SIFEM is advised by various committees, among which there is a Flood Committee. It is worth highlighting that one of the activities of such committee is the implementation of the *Documento Orientativo de la Respuesta ante la Hipótesis de Inundación en la Cuenca del Plata* (Guidance Document on the Response to Hypothetical Floods in the La Plata Basin) (Dirección Nacional de Políticas de Seguridad y Protección Civil de la Argentina, 2004).

In connection with Emergency management, SIFEM has reached a framework agreement with the *Comisión Nacional de Actividades Espaciales,* CONAE (National Commission of Spatial Activities) related to the use of satellite information. SIFEM is the Argentine institution empowered to activate the International Charter on Space and Large Catastrophes (CHARTER). CONAE acceded the charter in July 2003[56] (Dirección Nacional de Políticas de Seguridad y Protección Civil de la Argentina, 2004).

11.4.3.2. Bolivia

The *Viceministerio de Defensa Civil y Cooperación al Desarrollo Integral* (Vice Ministry of Civil Defence and Cooperation towards the Integral Development) within the *Ministerio de Defensa Nacional* (Ministry of National Defence) is the institution in charge of dealing with emergencies in accordance with the provisions of the *Ley de Reducción de Riesgos y Atención de Desastres* (Risk reduction and Disaster Care Act). Within this Vice Ministry, there are two departments:

1) *Dirección General de Atención de Emergencias y Auxilios* (General Directorate for Emergency and Aid Care), which works during the emergency, and

2) the *Dirección General de Cooperación al Desarrollo Integral* (General Directorate for Cooperation to Integral Development) which, through the *Plan de fortalecimiento a la gestión municipal para la prevención de riesgos, atención de desastres y reconstrucción* (Municipal Management Strengthening Plan for Risk Prevention, Disaster Care and Reconstruction), contributes to prevention awareness, capacity to

[56] This initiative also involves the European Space Agency, ESA, the National Centre of Space Studies, CNES (Centre National d'Etudes Spatiales) from France, the Canadian Space Agency, CSA, the Indian Space Research Organization, ISRO, and the National Oceanic and Atmosferic Administration, NOAA, from USA. Its goal is to facilitate access to satellite information in emergencies, either natural or caused by human action.

handle disasters and reconstruction of affected areas and sectors (Viceministerio de Defensa Civil y Cooperación al Desarrollo Integral de Bolivia, 2004).

Among the proposals by the *Estrategia Boliviana para la Reducción de la Pobreza* EBRP (Bolivian Strategy for Poverty Reduction), there is one which is linked to developing emergency programs in the event of natural disasters. This proposal refers to the future implementation of a *Sistema Nacional para la Reducción de Riesgos y Atención de Desastres y/o Emergencias,* SISRADE *(*National System for Risk Reduction and Disaster and/or Emergency Care), which involves all public and private institutions and organisations within the civil society. This will help in preventing, reducing and responding to risks and human, economic and environmental losses caused by natural disasters and/or emergencies, on a timely basis. Under the coordination of the *Consejo Nacional para la Reducción de Riesgos y Atención de Desastres y/o Emergencias,* CONARAD (National Council for Risk Reduction and Disasters and/or Emergency Care), Prefectures, Municipal Governments and regional entities will draw up and implement policies, plans, programmes and projects for the reconstruction, reactivation and economic recovery of productive processes in areas affected by disasters (Gobierno de la República de Bolivia, 2001).

The EBRP empowers the *Ministerio de Defensa Nacional* to take action for the prevention and reconstruction of disaster-prone areas. Assistance to individuals affected by natural disasters is in charge of the *Servicio Nacional de Defensa Civil*, SNDC (National Civil Defence Service) in accordance with the law. Prefectures and Municipalities will include in will include in their budgets all necessary resources to reduce risk, and counterpart funds, according to their financial possibilities, for rehabilitation, reconstruction and economic recovery of productive processes affected by natural disasters (Gobierno de la República de Bolivia, 2001).

11.4.3.3. Brazil

The Brazilian Civil Defence is organised as a system called *Sistema Nacional de Defesa Civil,* SINDEC (National Civil Defence System) and it is made up of a series of bodies. The *Secretaria Nacional de Defesa Civil,* SEDEC (National Secretariat of Civil Defence) within the *Ministério da Integração Nacional*, MIN (Ministry of National Integration) is the central body of the System, responsible for coordinating civil defence actions throughout the national territory (Secretaria Nacional de Defesa Civil, 2004 a).

The participation of the civil defence aims at reducing the consequences of disasters, by means of prevention, preparation for emergencies, response to disaster and post-disaster reconstruction. Participation includes various sectors, comprising the three government levels (federal, state and municipal), with an active participation of the community. The integrated and global organisation of actions by SINDEC provides a multiplying result, much more efficient and effective than the mere summation of actions by the bodies it is made up of (Secretaria Nacional de Defesa Civil, 2004 a).

Each and every SINDEC body has powers. However, the participation of the civil defence municipal body, i.e., the *Coordenadoria Municipal de Defesa Civil,* COMDEC (Civil Defence Municipal Coordinating Committee) is extremely important, since disasters usually occur in the municipality. The municipality must be prepared to immediately assist the population affected by any kind of disaster, thus reducing material and human losses. That is why it is of the utmost importance for each municipality to create its own COMDEC (Secretaria Nacional de Defesa Civil, 2004 a).

SINDEC implements the *Politica Nacional de Defesa Civil* (National Civil Defence Policy), which has scheduled activities to be carried out in response to disasters. This stage includes rescue aid, assistance to affected population and rehabilitation of the disaster scenario. Each of these sub-stages has in turn a series of guideline activities to attain their goals (Secretaria Nacional de Defesa Civil, 2000).

On the other hand, the goal of the *Centro Nacional de Gerenciamiento de Riscos e Desastres,* CENAD (National Risk and Disaster Management Centre) under the technical supervision of the *Departamento de Resposta aos Desastres e Reconstruçao, DRD* (Department of Response to Disasters and Reconstruction) is to be able to manage preventive and response actions by means of a computerised system with the aim of avoiding or reducing damage to society. These actions include the mobilisation of human resources, material and equipment, classification of data concerning risks of disaster and a daily monitoring of the parameters of dangerous events, which would make satellite data geoprocessing possible (Secretaria Nacional de Defesa Civil, 2004 a).

It operates on the bases of reaching agreements with Civil Defence state bodies and technical institutions with adequate human, material and institutional resources as well as information relevant to the development of activities by the SINDEC (Secretaria Nacional de Defesa Civil, 2004 a).

Within the SINDEC, criteria are established to declare an emergency situation or a state of public calamity. In a disaster situation, there are various factors that interfere to make things worse. Therefore, the municipality must take exceptional emergency measures and eventually compromise its administrative capacity. Thus, a situation of emergency or a state of public calamity is declared (Secretaria Nacional de Defesa Civil, 2004 b).

In order to define the Emergency Situation or State of Public Calamity, it is necessary to analyse predominant and aggravating factors. Predominant criteria are related to the intensity of damage (human, material and environmental) and the estimation of damages (social and economic). Aggravating factors are connected with conditions that might potentially generate greater impact during the disaster, for instance:

- Occurrence of secondary disasters;
- Lack of preparation by the local administration (general and civil defence);
- Degree of vulnerability of the municipality and the community;
- Disaster evolution pattern (Secretaria Nacional de Defesa Civil, 2004 b).

For example, in cases of unexpected disasters (severe) it is usually necessary to declare the state of emergency and public calamity, while gradual disasters (chronic) do not justify such action, since their evolution makes preparation possible, thus reducing damages and losses. Disasters triggered by a series of partial events, such as civil construction work accidents or traffic accidents do not amount to a state of emergency or public calamity even though they cause significant social damage (Secretaria Nacional de Defesa Civil, 2004 b).

11.4.3.4. Paraguay

The *Comité de Emergencia Nacional,* CEN (Nacional Emergency Committee), within the *Ministerio del Interior* (Ministry of Internal Affairs) is the institution responsible for coordinating preparations and some emergency operations in certain contingencies (floods, tornadoes and droughts). According to section 2 of Law 153 of 1993, the principal goal of the CEN is to prevent and counteract the effects of disasters caused by natural agents or any other origin as it promotes, coordinates and guides activities carried out by public, municipal and private institutions aimed at prevention, mitigation, response and recovery of communities affected by emergency situations.

The CEN was granted loans through international cooperation which have been implemented in the projects listed below:

- *Proyecto de Desarrollo Privado y Emergencia del Niño (Project for Private Development and El Niño Emergency)*, financed by the World Bank: its main goal is to prevent and mitigate the effects of "El Niño", by improving resources at the CEN and other institutions responsible for handling emergencies.

- *Proyecto de Zonificación de Áreas Inundables del Río Paraguay (Zoning Project for floodable areas of the Paraguay River)*, financed by FONPLATA.

- *Programa de Emergencia y Rehabilitación de Infraestructura (Programme for Emergency and Infrastructure Recovery)*, financed by the Inter-American Development Bank, IDB: its general objective is to contribute to mitigating risks and difficulties faced by individuals affected either directly or indirectly by economic losses in flooded areas or those rendered isolated by the deterioration of transportation infrastructure.

- *Proyecto de Fortalecimiento Institucional del Comité de Emergencia Nacional (Project for the Institutional Strengthening of the National Emergency Committee),* financed by the *Agencia Española de Cooperación Internacional - AECI* (Spanish International Cooperation Agency): targeted at strengthening the CEN at an institutional level to achieve a better fulfilment of its responsibilities.

On the other hand, since late November 2004, the Honourable Chamber of Deputies has been working on a bill, which creates the *Dirección Nacional de Gestión de Riesgos y Atención de Emergencias y Desastres*, DINGRAED (National Directorate for Risk Management and Emergency and Disaster Care).

11.4.3.5. Uruguay

Decree 371 of 1995 provides that the *Sistema Nacional de Emergencias* (National Emergency System), dependant on the *Presidencia de la República* (Presidency of the Republic), be composed of four bodies (*Comité Nacional de Emergencias* –National Emergency Committee–; *Consejo Nacional de Emergencias* –National Emergency Council–; *Dirección Técnica y Operativa Permanente* –Permanent Technical and Operating Directorate– and *Comités Departamentales* –Departmental Committees–). These bodies are set in motion according to how intense the emergency is. This institution is at the service of the community and its responsibility is to plan, coordinate, carry out, evaluate and manage situations of emergency or disaster that may occur within the national territory, territorial waters and territorial air space which might significantly affect the State, its inhabitants or their belongings when they exceed the response capacity of competent bodies (Presidencia de la República Oriental del Uruguay, 2004).

Among the competent bodies is the *Departamento V de Asuntos Civiles del Ejército Nacional* (National Army's Department V of Civil Affairs) whose tasks include, among others, the execution of Civil Defence and Protection operations within the framework of the various National Emergency Systems (Ministerio de Defensa de la República Oriental del Uruguay, 2004).

Other activities and international projects are:

- Agreement with the *Comisión Nacional de Actividades Espaciales de la República Argentina* (National Commission for Space Activities of the Argentine Republic), with the aim of receiving "on-line" images and satellite information for warning and monitoring forest Fires. A similar system for floods is being developed.

- The National Emergencies System is a member of the *Red ARCE* (ARCE Network), as a co-founder country of the *Asociación Iberoamericana de Organismos Gubernamentales de Defensa y Protección Civil* (Latin-American Association of Governmental Organisations for Civil Defence and Protection).

- A Strategic Plan to strengthen the system was being developed at the beginning of 2000s, in agreement with the HAP (Humanitarian Assistance Program) of the Government of the United States of America.

- The *Dirección Técnica y Operativa Permanente* (Permanent Technical and Operating Department) and the *Consejo Nacional de Emergencias* (National Emergency Council) within the *Sistema Nacional de Emergencias de la República Oriental del Uruguay* (National Emergency System of the Oriental Republic of Uruguay) have been designated Focal Point and National Platform respectively, to act before the International Strategy for Disaster Reduction Secretariat of the United Nations.

- The *Dirección Técnica y Operativa Permanente* within the *Sistema Nacional de Emergencias* has been designated National Coordinating Authority to act before the Inter-American Convention to Facilitate Assistance in Disaster Cases within the Organization of American States (OAS).

11.4.3.6. Multilateral Institutions (MERCOSUR[57] member countries)

The *Subgrupo de Trabajo N° 6 "Medio Ambiente" del MERCOSUR* (Working Sub-Group N° 6 "Environment" of MERCOSUR) is the multilateral instance with the greatest development and pertinence in the subject. Within the *Acuerdo Marco de Medio Ambiente del MERCOSUR*

[57] MERCOSUR is the Spanish acronym for the Mercado Común del Sur (Southern Common Market) created in 1991 and integrated by Argentina, Brazil, Paraguay and Uruguay. The main goal for the MERCOSUR is to promote free trade and the fluid movement of assets, peoples and currency. Bolivia, Chile, Colombia, Ecuador, Perú and Venezuela are associated members.

(MERCOSUR Environmental Framework Agreement), an additional Protocol has been drawn up which deals with cooperation and assistance in cases of Environmental Emergencies (Decision 14/04). This document has an indefinite duration and it shall be enforced 30 days following the deposit of the fourth instrument of ratification, which must be issued by the member countries (Consejo del Mercado Común del Sur, 2004).

This Decision has an annexed form named Notification of Environmental Emergency/International Assistance Application, in which the following is established: individuals/institutions among which the notification is circulated, location of the incident, type of emergency, detailed characteristics of technological/industrial/chemical accidents and natural disasters with environmental impact, effects produced, types of intervention, international assistance requested and previous coordination actions (Consejo del Mercado Común del Sur, 2004).

The Decision was signed by the *Consejo del Mercado Común* (Council of Common Market) on July 7th, 2004, in Puerto Iguazú, but to date, no country has made the corresponding deposit of ratification (Consejo del Mercado Común del Sur, 2004)

In summary, even when environmental problems have generated contingencies, accidents and catastrophes of various types in the La Plata Basin, the institutional approach has not been well developed yet. Countries have heterogeneous scenarios in terms of human and financial resources to carry out their activities within the sector, and bilateral relations have made scarce advances in terms of implementation tools.

11.4.4. Contingency plans

The contingency plan applied by the Civil Defence in Brazil is the best example of this type of non structural measures to prevent disasters. The *Manual de Planejamento da Defesa Civil* (Civil Defence Planning Manual), compiled within the context of the Brazilian Federal Civil Defence contains a detailed description of the stages of a Contingency Plan in the event of disaster. The contingency planning stages are (Secretaria Nacional de Defesa Civil, 2004 b):

- *Appointing the Working Group and Interpreting the Mission:* These two stages outline the Contingency Plan and its general goals.

- *Characterisation of Risks:* in order to obtain planning hypotheses and based on each hypothesis a contingency plan is drawn up.

- *Monitoring requirements*: monitoring requirements are defined; the result should tend to integrate and analyse global and regional information.

- *Definition of Actions to be taken:* these actions are carefully studied and defined for each general activity listed in the actions for response to disasters. During follow-up, these actions are chronologically detailed and scheduled according to the evolution of disasters.

- *Conferring Missions to SINDEC Institutions:* in this stage, a selection is made among SINDEC institutions (sectorial or supporting) to take over the responsibility of carrying out actions suggested in the previous stage. Selection is made according to accumulated experience or the institutional memory of local institutions that make up the SINDEC.

- *Establishing Coordination Mechanisms:* In this stage, a project manager and a working group are appointed for each sectorial and supporting institution selected in the previous stage. Once appointed, the working group becomes the focal point of the SINDEC in the Supporting Institution and its manager becomes a member of the working group of the Central Institution.

- *Planning Details*: In this stage, planning is portrayed in better depth and more articulately. Each support institution with missions conferred in previous stages must organise their responsibilities in detail, in coordination with both the Central Institution of the System and sectorial institutions. The detailed planning should, in principle, be developed as stated in the contingency plan and following the same stages. Once planning is concluded, the following are made: Contingencies plan (containing information relevant to all institutions that make up the SINDEC at a local scale) and Annexes to the Contingency Plan (describing logistic support, mobilisation of resources and the role of sectorial and support institutions).

- *Planning Promotion and Improvement*: the planning process is dynamic; thus, the Contingency Plan and its Annexes are subjected to periodic updating reviews. Once the Contingency Plan has been made, it is promoted, and training of the technical teams responsible for carrying out the planned actions begins. When training is over, it is important for the Contingency Plan to be tested by means of mock exercises, which –once evaluated– will contribute to improving the planning process.

On the other hand, the making of the Operations Plan is similar to the process established for the Contingency Plan and it is developed following these stages (Secretaria de Defensa Civil, 2004 b):

- Appointing the Working Group;
- Interpreting the Mission;
- Assessing damages;
- Monitoring Follow-up;
- Defining or Redefining Actions to be taken;
- Conferring Missions to SINDEC institutions;
- Establishing Coordination Mechanisms;
- Planning Details;
- Promoting and Implementing the Plan.

All the above listed stages, except risk assessment, are carried out after the fashion of contingency planning. The main difference is that, according to the pressure exerted by the events, the terms of elaborating, approving and promoting the Plan are very short. Operative planning in a real situation is significantly simplified when there is a contingency plan that can be adopted (Secretaria de Defensa Civil, 2004 b).

<u>Challenge:</u> Sharing Water between Uses and Users

<u>Overview</u>: It should be our common goal to promote peaceful cooperation and develop synergies between different uses of water at all levels, whenever possible, within and –in the case of boundary and transboundary water resources– between states concerned, through sustainable river basin management or other appropriate approaches.

12. Allocation of Water Resources

National experts on the subject have been consulted to give account of the situation with respect to competition for water use in each of the five basin countries. The questionnaire, sent electronically, is attached in the Annex IV to the chapter. Information is provided by country, in the items that follow.

12.1. Competition for water within countries

- <u>Argentina</u>

The lack of interinstitutional coordination and even communication and exchange of information among the different agencies generates overlapping of functions. Lack of coordination has favoured the development of intersectoral conflicts, especially among competitive uses like irrigation and hydropower generation. The Argentine Republic does not have yet a stipulatory noncontentious mechanism to solve the above-mentioned conflicts.

As examples of the mentioned conflicts, some corresponding to sub-basins draining into the Paraná River Basin in provinces of Semiarid Chaco can be mentioned. Thus, in the Pasaje-Juramento-Salado River Basin, there is a conflict resulting from the competition for water use for power generation and agricultural-livestock production (Salta Province), and for agricultural production and human consumption (Santiago del Estero Province). The latter conflict is also observed between Santa Fe and Santiago del Estero provinces, at low-water times, when the flow agreed (3 m^3/s in Jume Esquina) does not get to Santa Fe (Mugetti, 2004).

In north-eastern Buenos Aires Province, groundwater is used for irrigation and domestic consumption and both uses compete with one another. As a result, there is a salinisation process taking place due to the decrease in the aquifer's water levels. This conflict reduces water availability, particularly during the summer months, when demand is high (Mugetti, 2004).

- <u>Bolivia</u>

The –in many cases competitive– water uses and the increase in demand can generate intersectoral conflicts. In the country, there are conflicts resulting from consumptive uses like irrigation and drinking water, especially in the influence area of big cities (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

On the other hand, the “bofedales” (cushion peat-bogs) or elevated wetlands and associated aquatic ecosystems that are fragile and highly dependent on watercourses have been affected by water management projects. Although the relationship between surface and ground waters is not well known, it could be assumed that the Southwest of Potosí water exploitation project will put the existence of some lagoons and marshes in danger, which in turn will affect tourism, an activity that generates over 5 million dollars in that region (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

As regards water quality, the water used in mining activities is returned to the river contaminated with heavy metals and acid mine drainage (AMD). This is the case of the Pilcomayo River Basin, where there is high contamination due to long-dated mining exploitation (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

- Brazil

In Brazil, conflicts among the different water resources users are increasing. For example, in the south-eastern sector of the country, there are conflicts over water use in the Paraiba do Sul, Piracicaba and Capivari rivers basins, to mention some cases. In the southern region, the most visible conflict areas result from water resources demand for irrigated rice fields and water quality degradation, especially in intensive cattle-raising areas (Praciano Minervino, 2002).

Other conflicts among uses are observed in the Ibicuí River sub-basin (Uruguay River Basin), between water for city supply and water for rice irrigation. On the other hand, the use of agrochemicals has altered the quality of surface spring waters used for human supply, which generates growing costs in treatment of water for cities (Dias Coelho, 2004).

This conflict also takes place in other areas of Rio Grande do Sul, in the South of Brazil, where irrigation is carried out on an intensive basis –with low efficiency systems and enormous water waste– and water availability is more limited (Dias Coelho, 2004).

- Paraguay

The joint and agreed use of water resources under concepts such as water basin management is still not applied in Paraguay. There is a sectoral water use per type of user, who uses the resource without taking into account the rest of the uses or the basin in its entirety. Such is the case, for example, of “rice users” –a peculiar type of organisation established near watercourses– to use water in crop irrigation and that manages the resource only at district or political boundary level (Gamarra Lovera, 2002).

- Uruguay

As regards potential conflicts due to multiple uses of water resources, the sub-basins of the Negro River (affluent of the Uruguay River) and the Santa Lucía River (affluent of the La Plata River) are worthy of special mention. In the Negro River Basin the conflict arises due to competition for water volumes used in rice irrigation and hydropower generation, mainly in the catchment’s area of Rincón del Bonete reservoir. In the Santa Lucía River Basin, competition is essentially related to the quality of water intended for human supply –which includes Montevideo Metropolitan Area– and the agricultural activities in the basin, with an intensive use of fertilisers, fungicides and herbicides (Genta *et al*, 2004).

Upstream from the dams located in the Negro River, an important hydraulic infrastructure for rice irrigation has been developed. It consists of mainly private hydraulic works, whose owners are individual producers and companies. On the other hand, the rice crop expansion resulted in the construction of works for marsh drainage, water channelling, protection of areas to be irrigated, bringing about changes in water runoffs and movement. All this has brought about expropriation situations in neighbouring properties, with the resulting conflicts (Genta *et al*, 2004).

Apart from irrigation and generation uses, there is also demand for water in the forest development of the basin, where many thousands of hectares have been planted (Genta *et al*, 2004).

In the Santa Lucía River Basin and in the drainage area of the La Plata River, the main water uses are agricultural, supply to populations and industrial. Despite this multiplicity of uses, there have not been any option and allocation problems. Water for human consumption has the priority before any other use. The amount of existing works with irrigation purposes is important but in terms of water volumes with respect to the water availability of the basin, it is not significant (Genta *et al*, 2004).

In both the Negro and Santa Lucía rivers basins, there are pollution problems in urban streams associated to effluent and solid waste dumping, and irregular settlements in floodable areas.

12.1.1. Management mechanisms for allocation among sectors

- Argentina

The absence of a National Water Policy Act that establishes guidelines to be developed later on by the provinces, on relevant matters such as users' rights and obligations, water's economic value, the watershed as a management unit, the roles of public institutions, users' multisectoral organisations, etc, brings about a partial and sectoral approach to said matters.

At a provincial level, the legal situation is very varied. There are provinces whose regulations are well developed and others that do not have specific laws about some issues affecting them, like promotion of irrigated land, users' organisation, water rights, tariffs that include proper payment for water, aquifer management, etc. In other cases, the existing legislation is very old and does not include new concepts such as multisectoral management, economic criteria, institutional development, etc. In some provinces, there is not even a Water Act (Santa Fe and Tierra del Fuego provinces). There is also a proliferation of interprovincial institutions linked to water resources management, mainly sectoral, with frequent overlapping of functions and, at the same time, gaps and lack of proper institutional support for some procedures.

Provincial water laws or codes establish the priorities of water use; classify uses; regulate the concession regime by establishing the ways, times and procedures to award use and dumping permits and concessions and to collect royalties, taxes and other contributions; and determine sanctions and penalties, which include cancellation of concession. In general, they are scarcely flexible instruments that do not allow taking into account the economic, social and environmental value of water.

Since most waters are state-owned assets, express authorisation from the State is required in order to use them. When waters are within provincial domain, provincial governments hold granting power with respect to them. All water laws foresee the institute of “concession” for the exclusive use of waters. Various legislations also foresee “permission” as another type of water use authorisation. The concession types vary according to the areas where the legislation is going to be enforced but in general they have the following characteristics: a) the administration does not ignore the use and performance of concessions; on the contrary, exercising them is mandatory; b) water use must be effective and efficient and allocated to the specific purpose as appropriate in each case. If the concessionaire does not comply with these obligations, concession termination can be declared.

When waters are allocated to meet third parties’ needs, as in the case of supply to populations, the “business concession” is used, which is not related to other public domain assets.

Concessions of public water use are not contractual. They are not public law contracts whose award is mandatory just for the fact that the petitioner complies with the established legal requirements. On the contrary, their award implies an act of authority, issued in the exercise of discretionary public powers, not completely regulated, and always for the sake of some type of benefit or public interest.

Public water development concessions must be awarded by the competent organ through the special procedure determined by the law. The contents of said concessions are subject to the provisions of the legal system.

All provincial legislations give a preference order to the effects of awarding water use concessions. This priority order varies, with the exception of supply to populations which always occupies the first place in the preference order, according to the provinces, their characteristics, water uses and most relevant local economic activities. Groundwaters do not have a special priority regime for their management except very particular cases like Mendoza Province with its Laws 4,035 and 4,036 that establish a specific priority regime for this type of waters.

The priority regime constitutes an extremely important water policy principle in arid zones since water scarcity compels to set a preferential criterion to some uses with respect to others. The agricultural use is, in general, the second priority –after human consumption– many times together with the livestock use, with which it is closely related.

The preference order is also adopted for water distribution during water-deficit or low-water periods, so as to be able to ensure supply to populations in the first place, and then special uses according to the legally established order.

The old water laws like those of Mendoza and Tucumán provinces have a rigidlike priority regime; that is to say, it can only be changed legally. More modern codes like the ones of Córdoba, San Luis and La Rioja provinces have a semi-rigid system, which can only be modified by a well-founded resolution from the enforcement authority or by decree, a law being unnecessary. This system is preferable because, on the one hand, it provides security to rights and, on the other, it does not paralyse the State in the management of a strategic resource, particularly in times of change like the present one.

In Argentina, there are no legislations with a totally flexible system –as in Bolivia and Honduras law projects– where there is not a predetermined order, as a result of which the State is in charge of allocating or distributing water with an absolutely discretional criterion. This system could only be admissible in very humid areas, but it nevertheless creates legal insecurity that discourages investment.

Among the most rigid principles of water laws, there is the so-called “inherence principle” according to which irrigation waters are allocated in favour of lands and not their owners, for which they cannot be transferred or charged on separately from the benefited properties. Provinces with a greater irrigation tradition –such as Mendoza– give constitutional rank to this inherence principle, which leads to inefficiencies in the management of water resources.

A particular aspect of this problem is that, in general, little or no importance is given to the public registry of water use, development and discharge rights. Since users do not have documents that prove these rights and there is not a physical security of the resource due to the absence of reliable, up-to-date supply and demand records, legal security is not offered to users, thus hampering the development of a water policy that considers the minimum requirements of environmental protection.

- Bolivia

The Political Constitution of the State establishes in its Section 136 that the State has original domain to all waters and that the law will stipulate the conditions for their concession and award to individuals. This Section, included since the constitutional reform of 1938, changes the rights regime based in the 1906 Law completely, which until then allowed private domain over water. However, in spite of what was constitutionally stipulated, the existence and exercise of private rights would continue to be a reality for a long time, since even the Bolivian Civil Code of 1974 establishes a private water regime in its contents (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

The legal water framework in Bolivia is the Water Act[58] of November 1906. This Law has been partially repealed by later rules and only some of its provisions are still in force. Besides, a complex variety of sectoral laws and rules that include references to water have been drawn up, which makes their enforcement even harder (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

The ambiguities in the legislation motivated the need to change the water legislation existing in the country. The process became more dynamic as from 1994, with successive legal proposals made by the Government. An aspect to be highlighted is that the debate took place at a time of important changes in other sectors of the legislation, aimed at adjusting the role of the State to the new economic model in force. However, until 2002 the bill had been discussed and reviewed but none of the 32 versions obtained as a result were able to gain the necessary consensus to be passed and enacted (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

[58] The “Water Act” refers to the *Reglamento de Dominio y Aprovechamiento de Aguas* (Domain and Use of Water Regulations) of 1879, which became Law in 1906.

The priority of water use has been a subject of discussion in the different law proposals. Table 12.1 summarises the treatment of this subject in the 1906 Water Law, the state bills and the proposals from the social sectors.

Table 12.1. Bolivia. Treatment of water use priority within the legislation

1906 Law	Draft Water Bill (Nr 32)	Indigenous and Peasant proposal
Section 204 Priority order for concession of public waters: -Supply to populations; -Supply to railways; -Irrigation; -Navigation channels; -Mills and other factories, ferryboats and floating bridges; -Fish nursery ponds Within each type, preference will be given to the most important and profitable companies and, other things being equal, to those that previously requested the development.	*Section 8 (Use Preference)* Domestic and public use for urban and rural human consumption will have preference in the use and management of the resource water. For other uses regulated by the present law, use and development will depend on the conditions of the water resource availability, physical characteristics, socio-economic and ecological needs and territorial planning, within the concept of integral management of basins.	*Confederations' proposal* The first priority is water use for human consumption in urban and rural areas without any distinction. The second priority is for agricultural, livestock and community forest use. The other uses –energetic, mining, oil, industrial and agricultural and entrepreneurial forest– are in third place according to each region's specific characteristics. Water use for fish culture, hydrobiological resources development, and navigation activities will be regulated by the corresponding rules and laws.

Source: Unidad de Desarrollo Sustentable y Medio Ambiente, 2002

In the face of the government's proposal that the law must only establish use priority for urban and rural human consumption, the peasant organisations propose to establish use in agricultural, livestock and forest activities as a second priority. The peasant proposal reflects in part the concern for the present situation: diverse sectoral laws (Mining Code, Hydrocarbons Law), enacted in the 90's with the goal of favouring foreign investment, give priority to the respective sectoral use[59] (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

Things get even worse as a result of the absence of a jurisdictional mechanism to solve controversies concerning the use of water resources, except for the *Instituto Nacional de Reforma Agraria*, INRA (National Institute for Agrarian Reform) Law, which refers conflictive matters on water to Agrarian Judges. In practice, conflicts are solved in different instances, mainly civil courts, administrative instances –like Prefectures and Subprefectures– and in some cases the Police. At the rural community level, conflicts are frequently solved

[59] For example, the Mining Code establishes that water use is accesory to the mining concession, with the only condition that the volume that are restored shall comply with what is established by the Enviromental Law – something which does not always happen.

internally by peasant or irrigator organisations (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

The government's legal reform proposal states that the water-related controversies will necessarily be solved through Conciliation and Arbitration, but in the event that parties fail to reach an agreement as to the appointment of a conciliator or arbitrator, parties "*shall submit to the conciliation and arbitration body of the National Chamber of Commerce and its Statute*". Peasant organisations feel this poses the risk of favouring entrepreneurial sectors, apart from incurring significant costs in terms of the fees that must be paid to the Arbitrator or Conciliator. Therefore, they state that it is the local authorities who should be in charge of solving conflicts based on their "uses and customs" and that a National Water Authority should be used only when it is impossible to reach an agreement or when there are conflicts among different sectoral uses (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

As regards groundwater, the provisions of the 1906 Water Act are still in force. They establish private ownership of water within the properties where wells are opened. Owners have all the freedom to open wells, only making sure to keep a stipulated distance from well to well. Although these provisions do not agree with what is established by the Constitution, they are still applied in practice, for which there is a great amount of wells that supply water for irrigation, human and industrial consumption that are not subject to any type of effective control by the State. The continuous attempts to regulate and rule those uses according to the Constitution have been unsuccessful, for which groundwater use and development is still a quasi-private field (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

- <u>Brazil</u>

The so-called *Ley das Aguas* (Water Act 9,433/97) takes the concept of integrated water resources management as a way of supporting the multiple use of water. This Law establishes the federal and state responsibilities as regards providing the means that will enable proper management of water resources. Also, the responsibility for making decisions about what to do with water and what means will be used to achieve the goals established for its use is passed onto the community, represented in the Basin Committee.

Water is considered a scarce asset, since it is limited, finite and vulnerable and, therefore, it has an economic value that serves as the basis for establishing charging for its utilisation. All users have equal access to the use of the resource, but priority is given to water supply to populations and animals. Besides, the user concept is widened in this Act as compared to previous legislation, including all user sectors, regardless of their expression.

The Act establishes the mechanisms for water use, through the concession of rights to use. It is a control mechanism for the rational use of water resources, whose objective is ensuring the user effective exercise of water access rights, and acting as a quantitative and qualitative water use control instrument. This concession is an administrative act through which the granting public authority authorises the grantee to use a determined public asset for a certain period of time. Through the concession, the user receives authorisation or concession to make use of water. Concessions are granted by the *Agência Nacional das Águas*, ANA (National Water Agency), in the case of federal or international water bodies (Praciano Minervino, 2002).

The Act is focused on managing demand, thus enabling the rationalisation of water use. Therefore, the types of uses that can be made and the amount of users that can be taken into account will be determined according to water availability in the basin. Its utilisation, by means of a proper implementation of management mechanisms, lays the foundations for a proper demand management, since non allocated flows do not translate into new ways of demand but they will be used according to a previously established planning, paying attention to already identified needs (Praciano Minervino, 2002).

- Paraguay

There is no water law and the only legal instrument used at the moment is Law 294/93 on environmental impact study. Besides, a registry of water users –especially those who need to adjust to the environmental impact study law– has been made operational.

Although basin management has not been fully implemented in Paraguay, there are some successful water use allocation experiences in small sub-basins, such as Rory and Rorymi stream Basin (Paraguarí Department), whose waters are managed by a Water Authority made up of users. Said Authority manages from the upper basin, to water intakes, to reservoirs and to amount and use of both potable water and water for irrigation. It has its own regulations, and even though it is in full coordination with the local government, it is not directly related to the regional administration or the central government (Gamarra Lovera, 2002).

- Uruguay

The ruling principle is to ensure users the amount of water that is included in the water right title, with a high probability of 90 to 95% of occurrence. Water availability in the basin is analysed after considering registered users with water rights so as not to affect them and, in this way, new registration forms are taking into account.

There are regulatory frameworks that limit water extraction and supply for agriculture. Decree 160/980 of March 19th, 1980 and Decree 212/998 of August 5th, 1998 set limits to water for agriculture –mainly rice– to benefit hydropower generation. Since said limits are fixed on an administrative basis, they will need a study and analysis that supports or changes the adopted values in order to optimise the water allocation system in the basin (Genta *et al*, 2004).

Reservoir or water storage works must pass an ecological water flow that is estimated in 0.4 l/s per km^2 of a basin so as to preserve natural conditions downstream as much as possible.

Users take part in the analysis of registration forms and in how to distribute amounts of water if necessary. This involvement takes place through the respective Irrigation Board they are part of. It is worth remembering that both in number and in works, agricultural irrigation are the largest water demanding and user sector. In fact, Irrigation Boards were created in response to conflicts and difficulties that arose in the dry years, which were not satisfactorily solved. Said Boards were created by the Irrigation Act of 1997 (von Cappeln, 2002).

The Negro River Basin is the most relevant one in terms of multiple uses and situations of conflict and controversy that urge the need to create a management plan for the basin, giving priority to the area upstream from Rincón del Bonete reservoir and the system of water allocation by sectors (Genta *et al*, 2004). In this respect, the creation of a Negro River Basin Management Plan was foreseen in the year 2000 (von Cappeln, 2002).

12.1.2. Traditional water

- Argentina

Most waters are state public property, for which express authorisation from the State is required for their use. When waters are within a province, provincial governments are the ones that hold granting power with respect to them. In fact, all waters within their jurisdictions are provincial public property, except for those waters that belong to individuals, according to the rules of the Argentine Civil Code. Such is the case of surface waters that originate and disappear in the same property[60]; these waters lack public usefulness and are only useful to their owner. In this case, the land owner owns the waters in it and can make full use of them. Nevertheless, in all provincial legislations, the State has Police Power for their permanent control. It is thus established by the different provincial water legislations, such as Law 3,066 of the Province of Corrientes, Law 9,172 of the Province of Entre Ríos, Law 4,148 of the Province of Chubut, Law 7,017 of the Province of Salta, etc. (Calcagno, 2001).

Individuals have the right to use public property waters for drinking, washing clothes or other objects, taking a shower, watering and washing domestic animals, or extracting them by proper manual or mechanical means, making a rational and reasonable use. It is indispensable that riverbeds, banks and water schemes are not damaged, that the resource's quality, flow and normal regime are not altered and that the rights third parties might exercise are not harmed. It is thus established, for example, by the legislation Salta and Entre Ríos provinces, among others (Calcagno, 2001).

As regards originary peoples, the National Constitution guarantees the right to community possession and ownership of the land they traditionally occupy. Communities' legal status is recognised and their involvement in natural resources management and other issues of their concern is ensured. Although they are specifically quoted, these rights are not anchored in the Constitution; it is the Congress that must safeguard these rules. At the same time, the Law also assigns competencies to provinces (Barié, 2003). On the other hand, the consuetudinary right is not mentioned.

Since matters concerning award of land titles fall within provincial competence, the approach to this issue is extremely uneven. In some cases, provincial laws exceed the constitutional text. Some examples are: the Constitution of Chaco Province, which makes progress on the issue of legal status, the *Ley Integral del Aborígen* (Integral Aborigine Act) of Formosa Province or the creation of the Aborigine of Salta, with strong indigenous involvement (Barié, 2003).

- Bolivia

According to the Political Constitution (section 171), the social, economic and cultural rights of the indigenous peoples that inhabit the Bolivian territory are acknowledged, respected and

[60] The doctrine discusses the existense of water bodies that might belong to only one property, according to hydrological integration criteria (Calcagno, 2001).

protected, especially those that refer to their community lands of origin, guaranteeing as well the sustainable use and development of natural resources (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002). However, as it was mentioned earlier, the use of water and the solution of controversies about it are biased towards private sectors (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

The same section recognises the Legal Status of agricultural and peasant communities. This should be enough to legalise the existence of these organisations; however, the existence of said organisations is subordinated to formalities to carry out and written documents to be presented by the communities that traditionally keep an oral record of their history. The same happens with the acknowledgement of *Community Lands of Origin,* TCOs (Tierras Comunitarias de Origen), over whose resources peasant or indigenous groups hold use rights (Bustamante, 2002).

Peasants organisations pronounced themselves against a new Water Act (September and October of 2002) and made the Government agree to withdraw and file the Bill that the Congress was analysing at the moment. In that opportunity the Government committed itself to creating a commission that, in a 60-day term, had to elaborate an alternative Law that modified the rules against the rights of peasants, indigenous people and settlers, present in other laws and provisions. It was also established that while this Commission completed its work, "no rules or concessions on the resource water would be passed". It was also agreed to abrogate the 1906 Water Act (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

These agreements have not been observed yet, for which in the absence of a regulation that allows granting new rights, specific laws, sectoral provisions and administrative contracts are being used, which in many cases have the priority of guaranteeing the best conditions to private investment, leaving out social and even environmental considerations (Unidad de Desarrollo Sustentable y Medio Ambiente, 2002).

A Statute that establishes the indispensable minimum requirements to obtain the water resource concession according to the "uses and customs" prevailing in each region is proposed in the last version of the Water Bill. These rights must be proven and demonstrated by presenting suitable documents, which would bring about a hard-to-solve conflict due to the fact that it is practically impossible to define the contents of the indigenous-peasant customary law since it is made up of concepts, principles, practices and customs that are highly diverse in their formulation, application and reproduction and that, therefore, are dynamic (Bustamante, 2002).

In practice, most indigenous and peasant communities do not have a register of their water rights. Recently, with the acknowledgement of the TCOs, some rights have been awarded though very limitedly since, basically, human consumption, irrigation and only exceptionally fish culture are recognised. There are still references of the so-called "historical rights", that is, those that were awarded to communities during the colonial time. These were, in principle, just possession rights but later, during the Republican time, they were confirmed and extended further as ownership rights. It is in connection with these rights that repossession claims are still being made (Bustamante, 2002).

- Brazil

The Indigenous Statute (Law 6,001/73) safeguards the uses, customs and traditions of indigenous peoples. Indigenous lands include both reserves and communities and cannot be subject to contracts that affect their owners' full rights. Usufruct includes water sources and waters within the indigenous area (Gentes, 2001).

These provisions are reinforced in the Constitution of 1988, which recognises indigenous peoples' originary rights to formerly occupied land and endows the Federal Government with the responsibility to delimit them, protect them and ensure respect to them. These are lands with permanent ownership rights, which are imprescriptible. Exclusive usufruct of the riches of soil, rivers and lakes present in them is included (Gentes, 2001).

Later on, Decree 88,985/83 established that indigenous people have a right to the riches within the lands, with some exceptions[61]. The same instrument commits the Government to giving in concession exploitation tasks to companies, taking into account environmental protection and indigenous interests in the development of the tasks. Nevertheless, it is understood that this type of measures could affect indigenous people's well being (Gentes, 2001).

- Paraguay

According to the Constitution of 1992, indigenous peoples have rights to community ownership of land, in area and quality, enough for the conservation and development of their peculiar ways of life. Usufruct of natural resources remains under the State's control (Barié, 2003).

Constitutional provisions and other acts make up a coherent legal framework with respect to originary peoples' right. However, the distance between the law and practice has been significant, at least during the first years after the Magna Charta of 1992 came effective. Even though the Paraguayan State has widely recognised most indigenous rights, said rights cannot be object of a minimum exercise and usufruct by the peoples. In fact, the situation is serious in many cases, due to a lack of mechanisms for the protection of basic rights (Barié, 2003).

- Uruguay

All use rights must be registered to be opposable to management and third parties in case of concurrences, conflicts or supply difficulties.

According to the definition of water domain provided by the regulations, development rights are acquired through administrative concession, permission or authorisation. In the case of public domain waters, concessions or permissions are granted and there is no legal difference between them. Concessions are granted to build major works (like dams, for example), whereas permissions are granted for small wells, transitory uses or when none of the requirements are observed to obtain a concession (von Cappeln, 2002).

[61] Cases of strategic minerals for the country's safety and development (Decree 88,958).

In the case of private domain waters, an authorisation is issued, which removes a legal obstacle so as to use a pre-existing right. These authorisations are mainly applied to open groundwater extraction wells (von Cappeln, 2002).

12.2. Competition for water among riparian countries

- Argentina

Given the need to regulate shared uses and their effects, Argentina have signed transboundary agreements with its neighbouring riparian countries, especially in the case of the La Plata Basin, where it is a downstream country in almost every shared river.

In this basin, the widest regional framework is provided by the La Plata Basin Treaty, which provides for the joint and integrated study of the La Plata Basin, with a view to carrying out a multinational, bilateral and national works programme, useful for the region's progress in the following areas: navigation, hydropower, domestic and industrial sanitary uses, irrigation, flood control, animal and vegetal life conservation, road, river, railway and air interconnection, establishment of a telecommunications regime, regional complementation through the promotion and establishment of industries of interest for the Basin's development, economic complementation of bordering areas and mutual cooperation in education, health and epidemic control programs (Calcagno, 2001)

- Bolivia

Transboundary basins are subject of international law. The existing international legal instruments that have been subscribed or are accepted by Bolivia are the Declaration of Montevideo (1933), the Declaration of Asunción (1971) and the Declaration of Paris (1998). In the first case, it is established that no state is allowed to introduce any modifications into international watercourses that might be harmful to the riverbank of a riparian state, unless with its consent. The Declaration of Asunción, on the other hand, establishes that each state can use waters according to its needs, as long as it does not harm another basin state (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

In March 1998, the International Conference on Water and Sustainable Development approved the Declaration of Paris which, as regards transboundary basins, supports exchange of reliable and comparable data among neighbouring countries and fosters dialogue at all levels, especially at institutions and relevant international organisations, to define pluriannual programmes of common-interest and priority measures aimed at improving water management and the fight against pollution (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

- Brazil

According to the international public law, the principles applicable to the use of international watercourses must respect the existence of some preference order among the different possible uses, verifying those uses that complement each other and those in total opposition to each other. Any common development of shared water resources shall be carried out taking into account the watershed concept (Praciano Minervino, 2002).

If there is no formal agreement among riparian states, the resolution adopted at the 1976 Madrid Conference of the Association of International Law on Water Resources Management can be applied. Said resolution points out that the power states have over shared resources can only be put into practice by means of the right to equitable and reasonable use, through the conventional negotiation of the relevant factors of the water system in question (Praciano Minervino, 2002).

- Paraguay

Paraguay has an important number of transboundary watersheds, since more than 75% of its frontiers are defined by bordering rivers. As a result, binational agreements as well as intranational agreements are needed to manage the hydropower resources in question. Due to the nature of binational agreements and the time when they were drafted, it is difficult to control them, for which it is hard to demand development of water resources and observance of environmental regulations. Nevertheless, the mentioned entities have considerations within their annual operational plans, aimed at the sustainable use of water resources (Gamarra Lovera, 2002).

- Uruguay

Uruguay has international agreements with Argentina and Brazil with respect to rivers and other water bodies they share and that act as boundaries between states. In the case of Brazil, the use of international waters is regulated by the *Convenio para la Fijación del Estatuto de la Frontera entre Brasil y Uruguay* (Convention regarding the Establishment of the Statute of the Frontier between Brazil and Uruguay), signed in 1933. According to this regulation, each state has a right to use half the water flowing in frontier watercourses. Also, it establishes that it is not allowed to build works that could affect the water regime of the boundary river in a perceptible and lasting way, without previously agreeing with the other state on the execution of said works (von Cappeln, 2002).

In 1997, an Additional Adjustment to the Statute was signed in order to update its resolutions. This Adjustment established that water developments would require authorisation from the competent authorities of the respective riverbank. According to this regulation, the Frontier Commissions, among which is the Cuareim River Commission, will recommend a system of rational and equitable use of water with domestic, urban, agricultural, industrial and other purposes, giving priority to supply to populations (von Cappeln, 2002).

In the case of the border with Argentina, the *Tratado de Límites del Río Uruguay* (Uruguay River Boundary Treaty), signed in 1961, established the principles that had to be followed when elaborating a later statute that governed the use of the river. One such set of rules is the *Estatuto del Río Uruguay* (Uruguay River Statute), signed in 1974 (von Cappeln, 2002).

12.2.1. Transboundary rivers, lakes and groundwater aquifers

Next is a description of the main identified problems concerning the use of international water bodies per basin.

- Paraná River Basin (Argentina-Brazil-Paraguay)

Transboundary hydropower developments have an effect upstream and downstream, within the transboundary context. In the case of Itaipú Binational –the Brazilian-Paraguayan hydropower development built in the 1970's, which accounts for some 20% of the power installed in Brazil– the operation is carried out according to an agreement signed by Brazil, Argentina and Paraguay. This agreement foresees artificial runoff variation restrictions downstream from Itaipú in the Paraná River and then downstream from the confluence with the Iguazú River (Tucci, 2004).

The international agreement of Itaipú establishes that a variation cannot be greater than 0.5 m in one hour or 2 m in one day and speed cannot be faster than 2 m/s by natural causes. In March 2004, Brazil requested a modification of these parameters (Tucci, 2004).

- Bermejo River Basin (Argentina-Bolivia)

The conditions of scarcity and restrictions for water resources development generate or magnify conflicts in the use of surface or groundwater, seasonal or permanent, especially in the areas with greater water deficit (in the upper basin and in semi-arid Chaco). The poor knowledge of existing resources, the deficiencies in the legislation and the weaknesses of the institutional framework concerning basin management make it difficult to prevent these conflicts. Apart from the limitations characteristic of the hydrologic and sedimentologic regime of the Bermejo River, there are other specific causes to explain the conflict, such as local water table depletion, high salt concentration and deficient water infrastructure (COREBE-CONAPIBE, 2000).

The low agricultural use intensity in general and the low or null occupation with agroindustrial crops, affect farmers that compete for water rights with other economic sectors. Impacts include interjurisdictional conflicts among different users in one region (COREBE-CONAPIBE, 2000).

Throughout the basin, the issue of dam construction was supported by a plurality of governmental and nongovernmental stakeholders. The construction of three large dams in Bolivia, with marginal effects on certain lands to be flooded in Argentina, was agreed upon by the Governments of Argentina and Bolivia for water regulation and control as well as sediment control purposes. To date, the cost-benefit analysis has reviewed an array of investment and operational costs and possible benefits, including hydropower generation, irrigation and water supply to communities, and sediment control. These projects, if feasible, would promote water resources development and be a key factor in regional development. Funds should be made available partially by the Government of Argentina; construction financing and operation works have been envisaged in cooperation with the private sector for the Las Pavas, Arrayazal (Bermejo River), and Cambari (Grande de Tarija River) projects.

The initial agreement with Argentina was strongly questioned by the inhabitants of Tarija Department, who observed there was no type of royalty or charging for water or power, in spite of the fact that most of the catchment area was in Bolivia. After tough negotiations, Argentina accepted royalties for power in the neighbourhood of 14%, whereas payment for water remained pending. Peasant communities whose lands and properties would be flooded by reservoirs are against dams. National and international environmental institutions also question them due to the fact that they are located in a region with special ecological characteristics and would affect two protected areas, in addition to the fact that the benefits for the country are questionable considering economic and environmental costs (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

The financial and technical obstacles, including the modalities of the proposed concession, continue to delay the projects, in addition to doubts over their cost-effectiveness, environmental impacts and modifications in the river dynamics, and socioeconomic implications. Bolivia has less direct benefit and higher impacts, which may be offset to a degree by additional payments from Argentina, the mechanisms for which have to be agreed. The benefits in Argentina, directly related to the project objectives, include agricultural development, urban growth and development of secondary infrastructure (UNEP, 2000).

- Pilcomayo River Basin (Argentina-Bolivia-Paraguay)

The Pilcomayo River, which divides Argentina and Paraguay, has a moving bed which brings about problems of local boundary demarcation and water use (Tucci, 2004). In this basin the major problems are related to the livestock use.

- Uruguay River Basin (Argentina-Brazil-Uruguay)

In general, scarcity or lack of the water resource does not bring about problems in the main watercourse of the basin; the influence of the main river on its tributaries is not affected either (Genta *et al*, 2004). Potential conflicts, however, are observed in some areas or remain dormant in others, such as in the sub-basin of the Ibicuí River. There, the problem mainly relates to conflicts between water demand for irrigation of rice crops –of about 1.5 l/s/ha– and supply to cities, which is much lesser[62]. On the other hand, excessive use of pesticides has contaminated springs used for human supply, thus creating limitations to use (Dias Coelho, 2004).

Other contamination problems are observed in cities located on the banks of the main watercourse and tributary courses, due to dumping of effluents without previous treatment. Water quality, recreation and restroom facilities at beaches in towns adjacent to the river are affected (Genta *et al*, 2004).

The use of hot springs in the Uruguay River Basin is worthy to be highlighted. There are several wells in operation and others in the pipeline in the Salto and Paysandú departments, located in the vicinity of important hotels and tourism-related activities. In Argentine territory, wells have been built as well and more are intended to be built in the future (Genta *et al*, 2004).

[62] A hectare of rice requires a water volume equivalent to the volumen consumed by some 600 inhabitants (Tucci, 2004).

Besides all these water uses, there are also hydropower generation in the binational dam of Salto Grande, and fluvial, commercial and tourist navigation. The latter has a potential development that should be studied thoroughly so as not to generate future conflicts (Genta *et al*, 2004).

- Cuareim/Quaraí River Basin (Uruguay-Brazil)

In the Cuareim/Quaraí River sub-basin there is strong demand for water for irrigation on the Brazilian side as well as in the Ibicuí River, which poses a potential conflict with Uruguay as the flow of the main river is reduced (Tucci, 2004). In the Uruguayan sector water is also used for irrigation –main use– and for human supply. The waters of the Cuareim River and its tributaries are stored in reservoirs at a higher level to use irrigation by gravity flow or else are taken directly from the river (CRC-IMFIA, 2004).

Due to the high use of water, river regime has varied considerably through time and is strongly conditioned by the water uses made on both sides of the basin (CRC-IMFIA, 2004).

The strong water demand for irrigation generates conflicts with river conservation and human supply. The same happens with water contamination due to lack of effluent treatment in cities (Tucci, 2004). This occurs, for example, with domestic effluents dumped untreated upstream from the cities of Quaraí (Brazil) and Artigas (Uruguay), which, at low-water time, causes water reflux and contamination of bathing resort and water catchment areas in said cities (Conselho Nacional de Recursos Hídricos, 2002).

Agreements of understanding were reached among countries in the face of water supply difficulties and lack of control of activities in the watercourse. The agreements reached tend to direct the shared resource management on a progressive basis.

12.3. Allocation mechanisms

12.3.1. National legislation

- Paraguay

As regards controversies over water use, a Decree-Law of the year 1949 provides for the creation of a water council for conflict management and solution in the case of developments for agricultural use (irrigation rice).

- Uruguay

Actions are developed according to the rules contained in the Water Code, Decree-Law 14,859 of December 15th, 1978.

In order to avoid well interference, and properly manage the thermal resource, a "Management Plan" has been approved in Uruguay as well as the creation and operation of an

Advisory Board, represented by official agencies and users' representatives (Decree 214/000 of July 26th, 2000) (Genta *et al.*, 2004).

12.3.2. National/International agreements

12.3.2.1. National

- Argentina

Section 124 of the National Constitution establishes that "the original ownership over natural resources existing in their territory belongs to the provinces". As original owners of water resources, several provinces signed diverse agreements tending to create river basins committees, in case of shared water resources.

For example Tucumán, Santiago del Estero and Córdoba provinces signed a convention on July 3rd, 1967 (ratified by National Decree 8,231 that same year) in order to distribute flows regulated by the Río Hondo reservoir. Later, the *Comité de Cuenca Hídrica del Río Salí Dulce* (Salí-Dulce River Basin Committee) was created on February 25th, 1971 by the *Secretaría de Estado de Recursos Hídricos de la Nación* (State Water Resources Secretariat) by Resolution 83/71, on the grounds of an agreement between the Nation and the provinces of Córdoba, Santiago del Estero and Tucumán.

The *Secretaría de Estado de Recursos Hídricos de la Nación* created the Salí-Dulce River Watershed Committee on February 25th, 1971 on the base of an agreement between the Nation and Córdoba, Santiago del Estero and Tucumán provinces. This and other Basin Committees had stopped working at the end of the 1980's, after the State's Law Reform (Mugetti, 2004). Since 1998, Committees have become active again as a result of the worsening of water and environmental problems, which give way to interjurisdictional conflicts (Calcagno, 2001).

According to this reactivation, the Interjurisdictional Salí-Dulce Basin Committee will be made up of the Governors of the signatory provinces and the Minister of Internal Affairs, Federal Planning, Public Investment and Services, and Health and Environment. Its structure gives it the political level required to subscribe interprovincial agreements relating to the management of shared water resources. Its objective is to agree on and endorse joint or coordinated action proposals made by the signatory provinces, aimed at promoting and enabling an efficient, equitable and sustainable management of the Salí-Dulce River; preventing or minimising both water contamination in the basin and degradation of its environments; and preventing and mitigating damages caused by water surpluses or shortages and by erosion processes in its basin.

Among its main actions are: designing the necessary water management mechanisms or agencies for their joint or coordinated implementation, and studying possible modifications to the rules concerning water resources management in provincial jurisdictions, aimed at their harmonisation.

Said Interjurisdictional Basin Committee will act as a political level of decision-making, with reference to the joint or coordinated actions proposed by a Technical Basin Committee which will be made up of representatives –appointed by the provincial governments– of the relevant areas of the signatory provinces, the *Ministerio del Interior* (Ministry of Internal Affairs), the

Secretaría de Ambiente y Desarrollo Sustentable, SAyDS (Secretariat of Environment and Sustainable Development) and the *Subsecretaría de Recursos Hídricos de la Nación*, SSRH (National Undersecretariat of Water Resources).

This Technical Basin Committee is foreseen to invite to its meetings representatives of all sectors affected by the issues to be dealt with, both at the national and provincial level, and its work should be based on the "Guiding Water Policy Principles", which are shared by the parties and are included in the Convention with the aim of enabling search of agreements at a technical level.

Finally, National Law 25,688 on Environmental Water Management contains a clause concerning the creation of Basin Committees.

As regards service provision through private concessionaire companies of the State, as in the case of providers of potable water and sewer service in the big urban centres of the country, the rights and obligations of said stakeholders are established in their respective concession contracts, which were mostly subscribed in the 90's and, as it was stated earlier, have been strongly questioned and are being renegotiated. Also, regulatory frameworks have been drawn up for that sector.

In the case of Buenos Aires Province, for example, its Water Act establishes in its Section 3 the creation of an autarchic multidisciplinary public law entity that will be in charge of: a) planning, registry, establishment and protection of rights; b) police power; and c) observance and enforcement of other missions foreseen in the Code or laws that modify or replace it. Also, the Water Act establishes that said entity will set out its own organisation and operation based on operational and financial decentralisation. The Entity is called Water Authority and reports to the Executive Power.

The importance of the Bermejo River Basin as a key factor for the development of a vast area of the Argentine Northeast generated several initiatives tending to its development. Thus, in October 1981, the *Comisión Regional del Río Bermejo,* COREBE (Regional Commission for the Bermejo River) –an interjurisdictional agency with authority and competitiveness enough to manage the rational and multiple use of the basin's water resources– was created, on the base of an agreement between the Nation and the basin's provinces. COREBE's objective is to make decisions and manage actions needed for the integrated, rational and multiple uses of the basin's water resources, on a coordinated basis and taking into account the common regional interest of the parties that make it up (Calcagno, 2002).

Later on, in October 1982, the Argentine provinces of the basin signed an Agreement on the Bermejo River Water Quota Allocation, as a consequence of a study carried out by the then Basin Committee, in order to determine the availability of non-regulated minimum flows. The Agreement established the water quota allocation among provinces, saving a channel maintenance flow (COREBE, 2005).

- Brazil

Basin Committees are the authorities that gather the different water resources users (industries, irrigators and consumers), the public power and non-governmental organisations. One of its functions is that of approving the basin's Water Resources Plan.

After the Water Law was passed, various basin committees were created in Federal and State rivers. Within the La Plata Basin, the Basin Committees of Paraiba do Sul River (shared by the States of São Paulo, Minas Gerais and Rio de Janeiro) and Upper Paraguai/Pantanal (Mato Grosso do Sul and Mato Grosso) were created in March and December 1996, respectively. As regards state basins, Table 12.2 shows the Committees created in the La Plata Basin.

Table 12.2. Brazil - States Basin Committees located in the La Plata Basin

São Paulo State			
N.º	River / Legislation	N.º	River / Legislation
01	Ribeira de Iguape and Southern Littoral – CBH-RB -	12	Moji Guaçu - CBH-Mogi
02	Paraíba do Sul and Mantiqueira –CBH-PSM	13	Pontal do Paranapanema -CBH-PP -
03	Piracicaba, Capivari and Jundiaí - CBH-PCJ	14	São José dos Dourados -CBH-SJD -
04	Pardo-Grande - CBH-BPG -	15	Sapucaí-Mirim and Grande - CBH-SMG
05	Lower Pardo-Grande - CBH-BPG -	16	Sorocaba and Middle Tietê - CBH-SMT
06	Pardo	17	Tietê/Jacaré - CBH/TJ
07	Aguapei and Peixe -CBH-AP	18	Tietê-Batalha - CBH-TB -
08	Upper Paranapanema - CBH – AP	19	Turvo Grande - CBH-TG -
09	Upper Tietê - CBH-ALPA -	20	Baixada Santista -CBH-BS-
10	Lower Tietê - CBH-BT -	21	Sierra of Mantiqueira
11	Middle Paranapanema - CBH-MP -	22	Northern Littoral
Minas Gerais State			
23	Paracatu (Dec. 40,014 03/11/98)	29	Araçuaí (Dec. 40,931 16/02/2000)
24	Verde	30	Sapucaí (Dec. 39,911 22/09/1998)
25	Das Velhas (Dec. 39,692 29/06/98)	31	Paraopeba (Dec. 40,398 28/05/1999)
26	Pará (Dec. 39,736 15/07/98)	32	Caratinga (Dec. 41,155 29/06/2000)
27	Mosquito (Dec. 39,736 15/07/1998)	33	Tributaries of Pardo and Mogi-Guaçu rivers located in Minas Gerais (Dec. 40,930, 16/02/00)
28	Araguari (Dec. 39,912 22/09/1.998)	34	Piracicaba (Dec, 40,929 16/02/2000)
Santa Catarina State			
44	Camboriu (Dec. 2,444 de 01/12/97)	49	Conceição Lagoon (Dec. 1,808 de 17/11/2000)
45	Itajaí (Dec. 2,109 de 05/08/97)	50	Itapocu (Dec. 2,919 de 04/09/2001)
46	Tubarão (Dec. 2,284 de 14/10/97)	51	Peixe (Dec. 2,772 de 04/09/2001)
47	Cubatão (Dec. 3,943 de 22/09/93)	52	Tijucas (Dec. 2,918 04/09/01)
48	Cubatão (Norte) (Dec. 3,391 de 23/11/98)		
Rio Grande do Sul State			
53	Santa Maria	60	Pardo
54	Dos Sinos - COMITESINOS	61	Lower Jacuí
55	Guaíba Lake	62	Vacacaí and Vacacaí Mirim
56	Caí	63	Ibicuí
57	Gravataí	64	Tramandaí
58	Taquari e Antas	65	Ijuí
59	Camaquã	66	Upper Jacuí

Source: Praciano Minervino, 2002.

On the other hand, the *Consórcio Intermunicipal para o Desenvolvimento Integrado das Bacias dos Rio Miranda e Apa,* CIDEMA (Intermunicipal Committee for the Integrated Development of Miranda and Apa River Basins) started operating in 1998, and it gathers 23 municipalities of the State of Mato Grosso do Sul. CIDEMA seeks to encourage a process of integrated and participatory water resources management, for which the creation of two work teams (one per basin) was proposed. In the case of the Apa River, initiatives for the implementation of integrated management have been developed together with Paraguay, country with whom waters are shared (CIDEMA, 2005).

- Paraguay

As an example of the national agreement on water use, the *Comisión Nacional de Regulación y Aprovechamiento Múltiple de la Cuenca del Río Pilcomayo* (National Commission for the Regulation and Multiple Use of the Pilcomayo River Basin) can be mentioned, created in 1992 with the objective of adopting necessary measures to regulate waters in the entire course of the Pilcomayo River and to allow for the rational and shared use of resources within its basin. Said measures and policies will have to be included in an economic and social development plan that includes indigenous communities settled in the basin, taking into account, as well, the preservation of the zone's natural environment (Gamarra Lovera, 2002).

12.3.2.2. International

- *Comisión Mixta Argentino-Paraguaya del Río Paraná, COMIP* (Argentinean-Paraguayan Joint Commission for the Paraná River)

This Commission was created in June 1971 with the main goal of studying and assessing the technical and economic possibilities of the development of the Paraná River resources in the border between the two nations. Said development comprises water use for power generation, navigation, fishing, industry, agriculture, recreation, etc. Later agreements enlarged COMIP's sphere of competence to areas such as exchange of hydrological data with Itaipú Binational – in order to control flow and water level variation– and water quality control (COMIP, 2002)

A new agreement reached in 1992 entrusted the Commission with the task of drawing up a river statute, mainly intended for regulating the different water uses (COMIP, 2002).

- *Comisión Administradora del Río Uruguay, CARU* (Administrative Commission for the Uruguay River)

Created by the *Uruguay River Statute* and subscribed by both Argentina and Uruguay in February 1975, CARU has the main objective of becoming a suitable mechanism for the river's optimum development. CARU is empowered to prepare and enact a series of regulations intended to organise the uses of the river: navigation, fishing, bed and subsoil, etc. This set of rules is the so-called *Digest on the Uruguay River Uses* (Abadie, 1998).

The Statute itself establishes that each party will be able to use the river waters within their jurisdiction for domestic, sanitary, industrial and agricultural purposes, and they must report to CARU in case said uses affect in a significant way the river regime or water quality (Abadie, 1998).

In recent years, numerous wells have been drilled for hot springs use, both on the Argentine and Uruguayan banks. In order to avoid future controversies, wells should be drilled within a technical and legal regulatory framework agreed upon by both countries, which tends to the sustainable development of the thermal resource through time (Genta *et al*, 2004).

With respect to hydropower use, the *Comisión Técnica Mixta de Salto Grande, CTM* (Salto Grande Joint Technical Commission) is responsible for the administration of the Salto Grande Binational dam.

- *Comisión Mixta Brasileño-Uruguaya para el Desarrollo de la Cuenca del río Cuareim* (Uruguayan-Brazilian Joint Commission for the Development of the Cuareim River Basin)

Created in 1991, it is responsible for the implementation of the *Acuerdo de Cooperación para el Aprovechamiento de los Recursos Naturales y el Desarrollo de la Cuenca del Río Cuareim* (Cooperation Agreement for the Use of Natural Resources and the Development of the Cuareim River Basin). Among other goals, the signing parties agree to achieve a rational and equitable water use for domestic, urban, agricultural and industrial purposes as well as flow and flood control (CRC, 1991).

In 1997, a Supplementary Adjustment to the Cooperation Agreement was signed, which establishes the priority of water use for human supply for the riparian populations of the Cuareim River and the conditions for the use of the resource allocated to irrigation. In this last sense, maximum flow distribution and distribution conditions are specified; it is also established that every user must obtain a use authorisation from each country's competent authority, with the exception of specific cases of small individual users who use the resource to meet basic needs (CRC, 1997).

The rule establishes operational regulations for extractions, taking into account the river levels according to predetermined values in hydrometric scales and the use of the allocation system in case of pronounced low waters (von Cappeln, 2002).

Within the scope of the Agreement and the Commission, various joint and individual projects have been carried out, which aim at updating existing data and the knowledge of the basin. A project on the integrated management of floods in the Cuareim River Basin is being developed –with funds from WMO and the Japanese Government–, which is considered as a laboratory for the development of transboundary cooperation (Tucci, 2004).

- *Comisión Binacional Administradora de la Cuenca Inferior del Río Pilcomayo* (Administrative Binational Commission of the Lower Basin of the Pilcomayo River)

Created in August 1994 by Argentina and Paraguay, the Commission is responsible for the integrated management of the lower Pilcomayo River Basin, which comprises use and regulation of flows, project and execution of works and water quality. Within this scope, actions and agreements aimed at the equitable distribution of waters are made, so as to ensure runoff towards the marshland zone that exists both in Paraguay and Argentina. Also, studies are drawn up, hired and supervised and measures designed for assessing and preserving the ichthyc fauna are adopted (Congreso de la Nación Argentina, 1996).

- *Comisión Trinacional para el Desarrollo de la Cuenca del Río Pilcomayo* (Trinational Commission for the Development of the Pilcomayo River Basin)

On February 9th, 1995, the Constituent Agreement of the Trinational Commission for the Pilcomayo River Basin was signed by Argentina, Bolivia and Paraguay in La Paz, Bolivia, according to which the Trinational Commission is responsible for the study and implementation of joint projects in the Pilcomayo River aimed at the development of the Basin. The activities of the Trinational Commission began with these steps as well as an integration process among the three countries to equitably solve the use of natural resources in the Pilcomayo River Basin (Comisión Trinacional para el Desarrollo de la Cuenca del Río Pilcomayo, 2004 a).

As responsible for project study and implementation, the Trinational Commission is carrying out the *Proyecto de Gestión Integrada y Plan Maestro de la Cuenca del Río Pilcomayo* (Project for the Integrated Management and Master Plan of the Pilcomayo River Basin), with funds from the European Union. The general objective is to improve the living conditions of the population and their environmental surroundings, and strengthening regional integration. Among the specific objectives are: to deepen the knowledge of the hydrological and environmental aspects of the basin and to define the conditions for a better use of water and soil resources. Given the importance of erosive processes, actions directed toward stabilising erosion and reducing sediment contributions to the river are expected to be carried out (Comisión Trinacional para el Desarrollo de la Cuenca del Río Pilcomayo, 2004 b).

- *Comisión Binacional para el Desarrollo de la Alta Cuenca del río Bermejo y el río Grande de Tarija, COBINABE* (Binational Commission for the Development of the Upper Basin of the Bermejo River and the Grande de Tarija River)

On June 9th, 1995, the Governments of Argentina and Bolivia agreed on establishing a Binational Commission for the Development of the Upper Bermejo and Grande de Tarija River Basins. This Binational Commission is responsible for managing those two basins, so as to achieve the sustainable development of their area of influence, optimising the use of their natural resources, generating employment, attracting investments and providing for a rational and equitable use of their water resources (UNEP, 2000).

The Binational Commission has international legal status, autonomy in technical, administrative and financial matters and legal capacity to acquire rights and assume obligations. Among its functions are: selecting projects to be carried out; arranging funding for studies and projects selected; issuing international calls for bids; awarding contracts for water resources studies, programmes and projects; granting concessions for the execution and use of planned works and projects, without any guarantee or endorsement from the governments; contracting the services necessary for fulfilment of the Agreement's objectives; and planning and executing activities necessary for the development of the basins (UNEP, 2000).

A specific paragraph establishes that power generated by hydroelectric plants built in Bolivia must be sold on the Argentine market under the same conditions as for power produced in the Argentine Republic. Also, anyone constructing hydraulic works in the basins will agree with the parties not to exceed operational capacity during certain months, so as be able to accumulate water during high-water periods, and thus mitigate negative impacts downstream (UNEP, 2000).

Within the general objective mentioned in the previous subparagraph, the Parties seek, through this Agreement, to make better use of waters to meet, among others, the needs of domestic use, electric power generation, irrigation, flood control, exploitation of the ichthyc fauna, and industrial and recreational uses. The preceding statement does not imply an order of priority for water uses. When making all these uses, the Parties will agree on the ways to operate works to be carried out, and will adopt the necessary measures directed toward preserving water quality, preventing erosion and controlling sedimentation processes and floods.

12.3.3. Virtual water

Since the issue of analysing virtual water is still recent, there are not reports or official information in the La Plata Basin countries which consider the balances of virtual water.

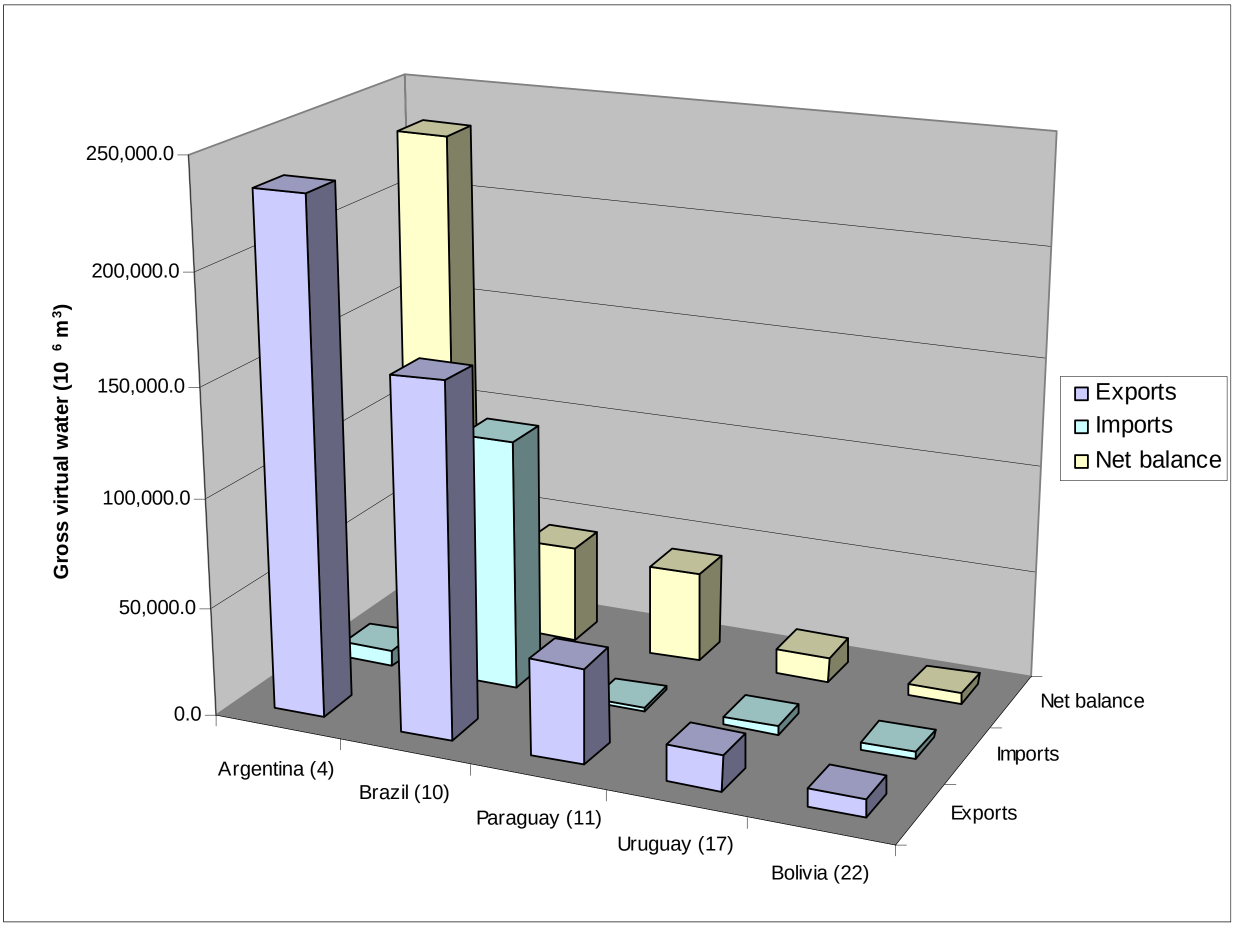
In the case of Uruguay, for example, the issue has not been discussed or analysed, in spite of being the country a big beef consumer and exporter, a large rice exporter, and so on, which requires high percentages of virtual water. Country's authorities and people acknowledge the importance of water in the productive processes of goods and services; Uruguay is also a tourist country and it finds in its water bodies and springs a valuable resource.

For the five riparian countries, a global report on virtual water trade in agriculture points out the participation of South America –and, specifically, of the countries of the La Plata Basin– as one of the most important virtual water exporter worldwide. If one country exports a water-intensive crop to another country, it exports water in virtual form. In this way, some countries support others in their water needs. This is the case of countries of the La Plata Basin and specially Argentina and Brazil. It could be thought that these two rich-water countries could profit from their abundance of water resources by producing water intensive products for export (Hoekstra & Hung, 2002).

The five countries of the La Plata Basin are included in the top-30 list of countries in terms of net virtual water export of the period 1995-1999. Figure 12.1 shows the gross virtual water exports and imports, the net balance and the position of the countries in the world ranking.

Brazil has net export in all the period, but net import of virtual water in one or more particular years (Hoekstra & Hung, 2002).

Figure 12.1. La Plata River Basin. Virtual water trade in agriculture by country (1995-1999)



Source: Based on Hoekstra & Hung, 2002.

Considering the five countries, the difference between exports and imports reaches a net balance of 330,812.3 10^6 m^3 of water. This amount represents around 90% of the net export volume of the whole South America, which is the second region of the world in the ranking of international trade volume. Exports are mainly to Western Europe, Central and South Asia, Middle East and North Africa; imports come from North America, North Africa, Southeast Africa and Oceania (Hoekstra & Hung, 2002).

12.3.4. Sharing the benefits

There is no information about the implementation of diverse forms of sharing benefits in the riparian countries. As an example, little progress has been made in introducing the economic value of water into the water allocation system in Uruguay, both among sectors and within the sector itself, in terms of a better cost-benefit ratio. In some cases, in order to avoid concurrence of water registration forms, economic and financial variables were handled to compare private investment projects and choose the most appropriate one.

Challenge: Valuing Water

Overview: It is a necessity to ensure that all water uses are reflected in economic, social, environmental and cultural values, and moves towards pricing water services to reflect cost of provision, taking account of the need for equity and basic needs of the poor and vulnerable.

13. Valuing Water

13.1. Integrated water resources management

13.1.1. Economic, social and cultural value of water

- Argentina

Each province decides and rules on its financial burdens in different ways, according to the importance of this resource. However, as common characteristics, the following can be mentioned (Calcagno, 2001):

- There are basically four types of taxes levied on public water users: ownership revenues such as water use canon or royalty and discharge canon; fee rates for services such as riverbed cleaning, works maintenance, work done with mechanical equipment; contributions to user associations for payment to employees in charge of distribution, etc; and contributions of improvements driven through the construction of works that benefit properties with water rights.

- Among taxes based on public water use, there is also the non-water use tax, which can be imposed by the State so as to ensure effective use of granted waters.

- The Legislative Power is authorised to set taxes, usually upon proposal by the Executive Power set forth in the budget bill.

To sum up, it is pointed out that tax levying of Water Rights is legally foreseen in most Provincial Legislations, but in practice, few provinces actually charge these taxes. In this regard, there is a chronic delinquency, especially in the agricultural use (Calcagno, 2001).

Tariff regimes for the different uses of water are far from integrating the concept of water's economic value. The concept of water as an unrestricted public asset is strongly rooted in the population, with the exception of arid regions. The economic crisis that affected the entire country, but most seriously affected some of the more vulnerable provinces, deepened a culture of "non-payment" from users and of "non-charge" from the State.

As regards irrigation, the nature of water that is intrinsic to land and the canon values set as a fixed amount –per year and per hectare– do not encourage the rational use of water.

There is no explicit acknowledgement of externalities or factors exogenous to the sector that influence water's economic value, not even of externalities or negative environmental costs that imply their mismanagement, such as scarce or mistaken consideration of the environment.

- Bolivia

Water's economic value is still being discussed in Bolivia. All Water Law's proposals drawn up by the Government include an acknowledgement of water's economic value and provisions that establish the need of a right-to-use license. The license is defined as the value paid annually for the concession that grants right to use and develop the resource (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

The license is not considered a tax and, therefore, it is different from the tariff which is established as a form of payment for services like potable water supply and sanitary sewerage. The license would be established in volume unit per time unit and would be mandatory for the concessionaire, according to which its non-payment for two consecutive years would bring about cancellation of the right. However, indigenous communities with traditional and consuetudinary rights to use and develop the water resource would be exempt from payment of the license (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

The proposal of social organisations also takes into account payment of a license for those who obtain an Authorisation for use and development of the resource. In the case of Community or Registry Rights, an exemption is proposed. However, since the new Law has not yet been enacted, none of theses provisions have become effective (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

- Brazil

The National Water Resources Policy includes charging for water use as one of the key instruments in water management. Charging is essential to create balance conditions between supply –water availability– and demand, and promotes a harmonious relationship among competing users. At the same time, water's character as an economic asset is acknowledged and users are provided with a reference of its value (Praciano Minervino, 2002).

Funds obtained from collection will be able to be used in implementing programmes and projects encompassed in water resources plans, and in fostering the socially suitable use of water, thus applying the polluter-payer and user-payer principles (Praciano Minervino, 2002).

Basin Committees are in charge of defining collection values according to the established limit values. The Federal State sets these limit values in the case of federal water bodies, whereas states do the same in the case of waters under their domain. The *Agência Nacional de Águas*, ANA (National Water Agency) is responsible for the collection of tariffs on water bodies under federal domain. Finally, the use of obtained funds will be made on a participatory, decentralised and integrated basis, according to each basin's Water Resources Plan (Praciano Minervino, 2002).

- Paraguay

Cultural valuation is still very poor. Social problems are a responsibility of the State and water's economic value is still not taken into account.

- Uruguay

In general, there is a very high cultural and social valuation of water. Due to the topography and undulating relief of the Uruguayan territory, there are watercourses in practically the entire country. Water is accessible in quantity and quality to a high percentage of the population. There is a generalised awareness, strongly rooted in the population, that water is free and that every inhabitant can enjoy it in recreational and beach activities, nautical sports, etc.

The Executive Power has legal authority to charge a canon for water use and, so far, this instrument has not been used.

13.1.2. Poverty, equity, the Millennium Development Goals (MDGs)

One of the eight main goals defined by the Millennium Declaration signed by the United Nations members in 2000 includes poverty reduction. Information provided by different sources remark that Latin American countries are left behind in the accomplishment of this goal, considering the strong economic crisis registered in the beginnings of 2000s. A short description based on the last country's reports is presented below.

- Argentina

In Argentina, poverty and hunger have been reduced in a 20%. The extremely indigence levels in the country caused a limited prevalence of infant malnutrition by the end of 1990s. The main problem of children was the low stature and the deficit in certain micronutrients, such as iron. The social emergency of 2001-2002 caused that a million people was living in insecure food conditions, since more than the 25% of the population did not have enough incomes to cover the nutritional requirements. Consequently, an increase in the prevalence of malnutrition among children (mainly under five years old) was expected, if public initiatives did not compensate the deterioration in the lowest incomes. In order to face this scenario, the National Government has restructured the social plans and concentrated all the economic resources in a Programme to attend food needs. Besides, new economic resources were sent to the Provincial Governments and to several NGOs devoted to help poorest families with severe problems to attend their food needs. These actions tended to strengthen the initiatives of create infant, scholar and communitarian feeding places, the self production of meals through communitarian farms and the food distribution among the poor population (Presidencia de la Nación Argentina, 2003).

- Bolivia

The last Millennium Goals advance report points out the little possibilities to reduce poverty and eradicate hunger (within the terms agreed in the UN document), due to the important economic crisis produced in the first half of 2000s, which impacted on the economic development and produced an increase in poverty levels. In relation to hunger, the crisis produced a decrease in the daily food consumption among the poorest population; this group consume around 30% of the daily kilocalories recommended by FAO (that is 2,100 kcal/day). This situation results in a chronic malnutrition affecting 50% of the under five years old children in the poorest homes (UDAPE-INE-Sistema de las Naciones Unidas en Bolivia, 2002).

- Brazil

Brazil had achieved important advances regarding poverty reduction, but a great part of the population still lived in extreme poor conditions by the end of 2004. The percentage of poor people (measured according to different methods) was more or less constant since mid 1990s. Another useful indicator, the share of poor population in food consumption, shows also signs of improvement, even though income distribution is still very unequal, mainly in the Northeast of the country. The country has over 1,000,000 children with weight deficit. As far as this indicator severely expresses the situation of insufficient nutrition, it shows, in a overwhelming way, that hunger is still a serious problem in Brazil. The reason is not lack of food (in fact, Brazil produces more food than required by its population) but the impossibility of great population sectors to access to food (Governo da República Federativa do Brasil, 2004).

- Paraguay

In Paraguay, the latest document on Progress toward the Millennium Goals does not consider either that it will be possible to reduce hunger and poverty. In fact, both the poverty and indigence levels increased between 1995 and 2001: the percentage of poor people increased from 30 to 35%, whereas the amount of indigent people climbed from 14 to 16%. Of the total of people in a situation of indigence, 76% live in rural areas. As regards hunger eradication, chronic malnutrition problems have not decreased, since the prevalence of low weight for age was 4.5% in 2001, whereas in 1990 the percentage did not reach 4%. The incidence of malnutrition is higher among women and in poor households where child malnutrition is three times higher than in non-poor households (Sistema de las Naciones Unidas en Paraguay, 2003).

As a challenge to overcome the present situation, the government of Paraguay foresees the implementation of a social protection and advancement programme as a short-term measure. The Plan for the first 100 days of the government that took office in 2003 prioritises the fight against poverty, which is connected with existing strategies such as the *Estrategia de Reducción de la Pobreza y la Desigualdad,* ENREPD (Strategy to Reduce Poverty and Inequality). As long-term measures, the government proposes implementing state policies intended to achieve macroeconomic stability, encourage investment, foster education and health, among others (Sistema de las Naciones Unidas en Paraguay, 2003).

- Uruguay

In Uruguay the situation is similar to the rest of the countries. Even though there is a low incidence of indigence, the percentage of the population in such a situation grew from 1990 to 2002, first slowly (until 1994) and speeding up later. The percentage of people living in a situation of poverty rose as well. Chronic malnutrition, as a measure of the situation in terms of hunger eradication, has accompanied the trend of poverty rates; after a decreasing trend between 1990 and 1995, there was a reversal and a consequent increase in the amount of children with chronic malnutrition (Sistema de las Naciones Unidas en Uruguay, 2003).

13.1.2.1. Water and gender

- Argentina

There is a generalised opinion that in Argentina there would not exist any significant social, cultural or work discrimination against women. On the contrary, and due to the strong association of learning, healthy food and hygiene habits with the school and home environments, women -as mothers and teachers- are majoritarily considered to play a key role in this matter.

In other cases, as a result of misery, poverty and cultural issues, women must partially or totally provide for their families, as a result of which the teaching role might not exist.

- Paraguay

In the Policy set out, women's role is fundamental, having considered that it is basically the least privileged sector and the one directly affected by water access-related problems.

- Uruguay

Experiences involving the male or female gender in water-related activities are unknown. It is understood that potable water coverage, with a high percentage of household potable water connections and sewerage service, has not shown the link between gender and water (von Cappeln, 2002).

In areas where access to water is made through standpipes and in rural areas, the gender-water ratio is clearer. Nevertheless, data that allow establishing links in this sense, such as hours spent in water transportation or supply, are not available (von Cappeln, 2002).

13.1.2.2. Role of water in poverty eradication

In this regard, a summary of the situation reported by the five countries in the latest progress reports for the MDGs is offered.

- Argentina

In the 1990's numerous programmes and projects were created, with international financial aid, aimed at the institutional strengthening of provincial and municipal regulatory agencies, identifying needs and technical solutions, financing investments for the expansion of sewer and drinking water services and improving the urban habitat. At the end of 2005 there was no global diagnosis on the results of the initiatives. However, it is certain that the works have impacted on the basic sanitation services coverage. At any rate, since the areas without coverage are, in general, poor sectors of lower paying capacity, privatised companies that were granted the license to provide services were not encouraged to invest in the major urban areas of the country. Meanwhile, the State plays a regulatory and monitoring role and seeks financing for the development of new networks in small towns, which decreased dramatically as a result of the national and provincial fiscal crisis (Presidencia de la Nación Argentina, 2003).

- Bolivia

The coverage of basic services in Bolivia has improved substantially in the early 2000's, as compared to the previous decade. However, in spite of these advances, the government deems it rather unlikely to fulfil the Millennium Goals in this sector, mainly due to the lack of enforcement of regulations or laws and the institutional weakness to do so (UDAPE-INE-Sistema de las Naciones Unidas en Bolivia, 2002).

The *Estrategia Boliviana para la Reducción de la Pobreza*, *EBRP* (Bolivian Strategy for Poverty Reduction) gathers together the main guidelines to follow in order to achieve a better quality of life. As regards water resources, the EBRP introduces the subject as a transversal component of the environment, taking the basin as a reference unit for the sector's policies - water resources master plans, flood control plans- as well as for soil and desertification control policies (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

According to the EBRP, the water resource is a social, scarce, non-renewable asset, fundamental for the population's survival. It acknowledges the absence of an institutional and regulatory framework suitable for observing these principles and encourages consensus building among the different social stakeholders -including indigenous people, peasants and settlers with consuetudinary rights as regards water use and development- to draw up a specific water resource rule. The institutional framework will have to take interdepartmental basins as a reference unit (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

This participatory approach simply remained in a statement, since the EBRP did not propose effective participation mechanisms either in water management or in the preparation of plans. All these problems appear again in draft Water Bills and have created public mistrust, especially among original communities (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

- Brazil

Efforts by the Brazilian government to revert the general basic sanitation scenario were limited by the economic and financial crisis during the 90's, which led to oscillations in the sector's annual average investment. As of 2003, the sector saw recovery prospects and started to get priority attention from the government (Governo da Republica Federativa do Brasil, 2004).

Within the universe of population with deficient access to drinking water, the metropolitan areas of the country considered a priority in this regard hold nearly 30% of inhabitants who live in houses deemed inappropriate. On the other hand, 85% of small municipalities have a population under 80,000 inhabitants and show sanitation services coverage rates lower than the national average standards (Governo da Republica Federativa do Brasil, 2004).

- Paraguay

Paraguay is still a country that depends to a great extent on natural resources, and most particularly on water resources for its development. Water is a key factor to eradicate poverty in the country.

Paraguay suffers serious problems in terms of water supply and sanitation although an increase in coverage was recorded between 1992 and 2005. The greatest differences in terms of deficiencies are between urban and rural areas and between poor and non-poor sectors. According to the trend, it is considered that a substantial improvement in the access to drinking water is not likely to be achieved (Sistema de las Naciones Unidas en Paraguay, 2003).

- Uruguay

There is an awareness of the problems that generate contaminated water sources or non-potable water consumption, with the outbreak of different waterborne diseases. The country's sanitary authorities, national and departmental, are fully aware of these problems. Development and extension of potable water networks to marginal zones is required.

Between 1991 and 2000 improvements have been observed in terms of drinking water supply, mainly in urban areas. Therefore, the government estimates that the fulfilment of the development goals is not in jeopardy, at least in this aspect. However, the sanitation service behaves differently. It requires high densities of population to make the extension or creation of networks viable. This contrast with the way urban peripheral areas grow, where the most disadvantaged population is concentrated. The same occurs in smaller urban centres and rural areas (Sistema de las Naciones Unidas en Uruguay, 2003).

As regards extreme poverty or indigence in irregular or precarious settlements, the State plays social role through *Obras Sanitarias del Estado*, OSE (State Sanitary Works) by installing water water supply taps for free.

13.1.2.3. Financing of water related MDGs

-Annual investments in water resources sector

- *Argentina*

Data for the 1997-2001 period reflect an important temporary variability as regards amounts invested in the different categories included in spending on water resources. The largest amount recorded was in 1998 with some 340 million pesos -equal to dollars- that accounted for 0.74 % of the total national public administration spending. In the year 2000, spending decreased by 42% from that of 1998, thus reflecting the country's economic crisis, and its share in total spending decreased to 0.54% (Calcagno, 2001).

The most significant fields are those related to potable water supply, urban sewerage and drainage (Water and City), general management (Governance) and water supply and management works for rural protection against floods (Water and Food, and Water and

Climate). This distribution varies depending on the years, with a relative increase, during the year 2000, in supply and support for needy populations plans (Water and Poverty, 19%) and flood plans (Water and Climate, 27%) as part of the pronounced decrease in total investment that year (Calcagno, 2001).

- Bolivia

The 1998-2002 budget for public investment in sectors that use water -a definition that includes from mining and irrigation to environment, fluvial protection and basin management- was mainly based on external funding (54% of the total amount). Although there are no available data concerning realised investment, it is known that it is generally lower than planned investment (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

In the irrigation and microirrigation sector, planned public investment ranged between 14 million dollars in 1998 and 18 million dollars in 2001. In view of these data, the draft proposal of the National Irrigation Plan estimates the required annual investment in the sector over the next years in approximately 50 million dollars (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

In the potable water and basic sanitation sector, the *Estrategia Boliviana de Reducción de la Pobreza* plans an investment of 681 million dollars, that is, an average of 136 million dollars per year (Unidad de Desarrollo Sostenible y Medio Ambiente, 2002).

- Uruguay

During the 1997-2000 period, the Water Resources sector annually spent 6% of the Central Government Expenditure. If expenditures generated by potable water supply and sanitary sewerage are differentiated from those belonging to water resources management, some 5.6% is observed in potable water supply and sanitary sewerage, and 0.34% in water resources management (von Cappeln, 2002).

- Privatisation of water sector

- Paraguay

There is a privatised sector for potable water supply, known as “aguateros” (water carriers), which provides services in those areas not covered by *Empresa de Servicios Sanitarios del Paraguay*, ESSAP (Sanitary Service Company of Paraguay) or the *Servicio Nacional de Saneamiento Ambiental, SENASA* (National Environmental Sanitation Service); this sector is regulated by ERSSAN’s Law 1614/00.

- Uruguay

Geographic areas have been granted in concession to be managed by national and international private companies for potable water supply and sanitation. There have been opinions in opposition to it, with their for-and-against arguments. While some support them, others reject them. In short, Uruguayan citizens approved a constitutional reform at the ballot box on October 31st, 2004, which prevents potable water and sanitation services from being provided by non-state companies.

13.1.2.4. Water pricing

- Argentina

As regards potable water and sanitation, historically, the services provided by *Obras Sanitarias del Estado*, OSN (Sanitary Works of the Nation) did not have tariffs based on water volumes consumed, since the company started operating all over the country, considering factors related to household characteristics -land surface, covered surface, antiquity, construction quality, area where property is located, etc. This regime established a cross-subsidy among users with greater purchasing power to those with fewer resources. This criterion was kept with the provincialisation of the services carried out in the 80’s.

Tariff regimes based on consumption metering started to be applied in the 70’s in small rural towns only as a result of the demands of the Inter-American Development Bank (IDB) and the *Servicio Nacional de Agua Potable*, SNAP (National Service of Drinking Water) for financing the respective works. The generalised experience was that meters stopped working due to lack of maintenance or breakage, thus discarding the reading system and returning to a non-volumetric flat tariff.

In general, metering-based tariffs predominate in systems managed by cooperatives. Goals were fixed in the regulatory frameworks for water service concessions to turn flat rate systems to volumetric. In metering-based systems, the existence of the variable rate -amount to be paid by users who exceed the minimum consumption set in the flat rate- promotes rational use of water.

Historically, tariffs have been set by each jurisdiction’s political power, even in the case of private companies. Said companies must study their tariff framework and subject it to the approval of the corresponding public powers.

At present, in services provided by public entities, tariffs are, in general, hardly enough to cover system operation and maintenance costs, whereas in services provided by private companies, besides the mentioned costs, they also include estimates for expansion of services, depreciation and amortisation of goods and facilities and profitability of companies.

As regards low-irrigation agriculture, water distribution services were historically provided by state-owned *Agua y Energía Eléctica S.E.* (Water and Power State Society), also with cross-subsidies from power generation to sectors devoted to low irrigation output. The 80’s also brought about the provincialisation of said systems (around 800,000 ha).

The average global efficiency of systems is low -of approximately 40%-, mainly due to poor water management and application to crops. Traditionally, the “irrigation canon” tried to cover systems’ operation and maintenance costs, but through payment of an annual amount per hectare. There are also situations concerning the “political values” of the canon as well as low collectibility-related problems. With the exception of cases in which Irrigation

Consortiums were created and put to work (Mendoza, Córdoba and Salta provinces, among others), services are still supplied by provincial public agencies.

In the 90's, there was a growing awareness of the importance of metering-based consumption to manage potable water demand. However, the significant investment needed to provide meters determined that their widespread use was slow and difficult and that both tariff systems (volumetric and flat rate) coexisted.

Consumption metering systems are based on two parameters: a flat charge, which can include minimum consumption and a variable charge determined in terms of m^3 consumed above that value. Private companies that provide potable water and sewer service are insistently demanding updating of their tariffs, mainly due to the high service development costs they have been facing since Argentina exited from currency convertibility at the beginning of the year 2002. The issue of tariff gaps, strongly claimed by companies from the potable water and sanitation sector, remains unresolved.

Collection of canons for water use in industrial processes takes place preferably in oil exploitation. In general, the tariff structure includes a flat charge per captured m^3, whereas collection of canons for polluting discharges has a simple tariff structure with a unitary charge per annual discharged volume, which varies according to type of polluting industry, or one of a more complex type, like the one applied in the metropolitan region of Buenos Aires, Decree Nr 674/88 and amendments, which establishes amount to be paid in terms of weighted load and concentration of polluting substances.

Also, there is a generalised idea in the Argentine Republic that the State is responsible for execution, operation and maintenance of infrastructure works necessary to ensure that availability, as it has historically done it through its strong national companies that sprang up during the first half of the 20th century.

Except some exceptions, like the presented case of water for irrigation in Mendoza Province, recovery of costs resulting from said activities was not a relevant matter. This approach did not have economic sustainability and it brought about the already-mentioned conflictive situations, as a result of which the private sector was requested to cover delivery of services.

- <u>Bolivia</u>

In big cities, tariff for potable water service must cover not only operation and maintenance costs but also return on investment (capital costs). It does not apply to most municipalities, for whom Basic Sanitation Law 2,066 and (proposed) regulations foresee direct and indirect subsidies for water and sanitation projects (Unidad de Desarrollo Sostenible y Medio Ambiente, 2001).

The Bolivian State transferred administration of various irrigation systems built since the 50's with public funds. In these cases, irrigator associations assume operation and maintenance costs. In general and as it happens in other countries, collections for water use do not allow recovering investment made in irrigation projects (Unidad de Desarrollo Sostenible y Medio Ambiente, 2001).

As regards the hydroelectric sector, most of power generation is in the charge of private companies, as well as transportation and most of distribution. Together with the sector's privatisation process, legislation was enacted, which creates the regulatory framework and includes a Superintendence of Power. There are subsidies for transmission systems in rural areas and for small isolated power systems, through rural electrification programmes or even international cooperation programmes for small projects (Unidad de Desarrollo Sostenible y Medio Ambiente, 2001).

- Paraguay

In Paraguay, a rural tariff is applied in areas where population is lower than 10.000 inhabitants, and an urban tariff is applied in populated centers with more than 10.000 inhabitants. In the former case, tariff value is set by the *Juntas de Saneamiento* (Sanitation Boards), dividing the expenses amount among the users. In the latter, 0.49 dollars per cubic meter are charged.

- Uruguay

Public service tariffs are controlled and approved by the Ministry of Economy and the *Oficina de Planeamiento y Presupuesto,* OPP (Office of Planning and Budget) and/or the Executive Power. For domestic use or supply to populations, they are countersigned by the Executive Power through Decree, after proposal of state-owned entity OSE.

As for industries, if they use the public network, they have tariffs set by OSE. If they use their own water source, for example a reservoir or a groundwater well, water is not charged and tariffs do not exist in that connection.

For the irrigation sector, the State does not charge for water use. However, some producers associate with water resources investment projects and pay for the water services they receive, which is a way of "paying for water".

Challenge: Ensuring the Knowledge Base

Overview: The knowledge in water resources should be developed, maintained and disseminated in such a way that all societies feel part of these processes and benefit from them.

14. Capacity building

14.1. Education

In general, the La Plata Basin countries exhibit a high level of school education. This is reflected in the low illiteracy rates, mainly in Argentina, Paraguay and Uruguay (Table 14.1).

The same table shows that considerable rate improvements have been recorded between 1990 and the present decade. In effect, overall illiteracy rates have decreased in all cases, and more significant improvements emerge in the cases of Bolivia and Brazil, the two countries presenting the worst situation with respect to this indicator.

Table 14.1. La Plata River Basin. Illiteracy rate by gender and country.

Countries	Illiteracy Rate (Population Aged 15 and Over)					
	Year 1990			Last Registered Data*		
	Total	Male	Female	Total	Male	Female
Argentina	4.3	4.1	4.4	2.5	2.1	2.1
Bolivia	21.9	13.2	30.2	13.3	6.9	19.4
Brazil	18.0	17.1	18.8	13.3	13.3	13.3
Paraguay	9.7	7.6	11.7	6.7	5.6	7.8
Uruguay	3.5	4.0	3.0	3.2	3.7	2.7

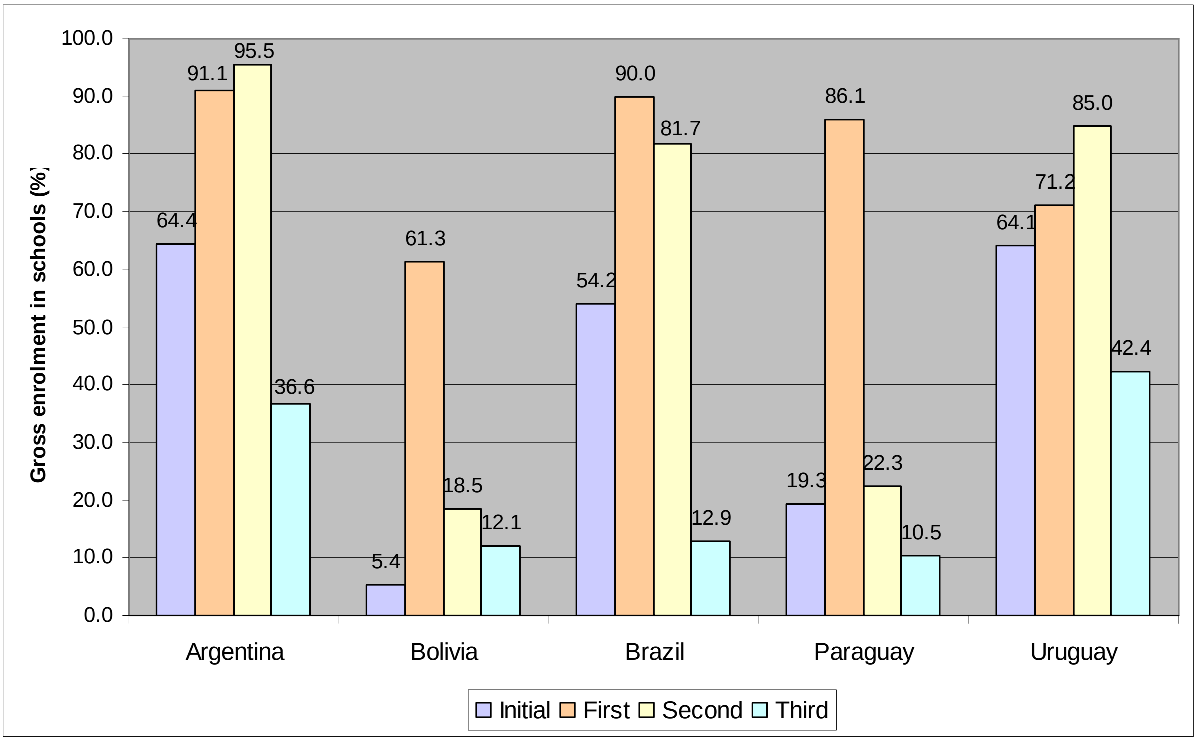
* Last registered data in Argentina and Bolivia, 2001; Brazil, 2000; Uruguay, 1996. Estimated data for Paraguay (CEPAL, 2004 a)
Sources: CEPAL 2004 a; INDEC, 2001; INE, 2001 a; IBGE, 2000; INE, 1996.

Regarding gender, females have a higher illiteracy rate, primarily in Bolivia, where gender differences are marked in this respect (17% in 1990 and 13% in 2001). In general, there is also an improvement in illiteracy rates by gender, improvements being more significant in the case of females.

14.1.1. Enrolment in schools (Primary, secondary and high school)

The school enrolment rate in four educational levels: initial (pre-school), primary, secondary and tertiary is another indicator that describes the basin's situation with respect to education. The information is presented in Figure 14.1.

Figure 14.1. La Plata River Basin. Enrolment in schools, by country and level.



Sources: INDEC, 2001; INE, 2001; IBGE, 2000; DGEEC, 2002; INE, 2003

Argentina has the highest percentage of enrolled population, especially in secondary school (95%). Uruguay also exhibits very good secondary and tertiary (the highest in the basin) enrolment percentages. Brazil has a high rate of enrolled population in primary school, like Bolivia and Paraguay. Bolivia and Paraguay, on the other hand, present the lowest enrolment rates in the basin, considering all four levels.

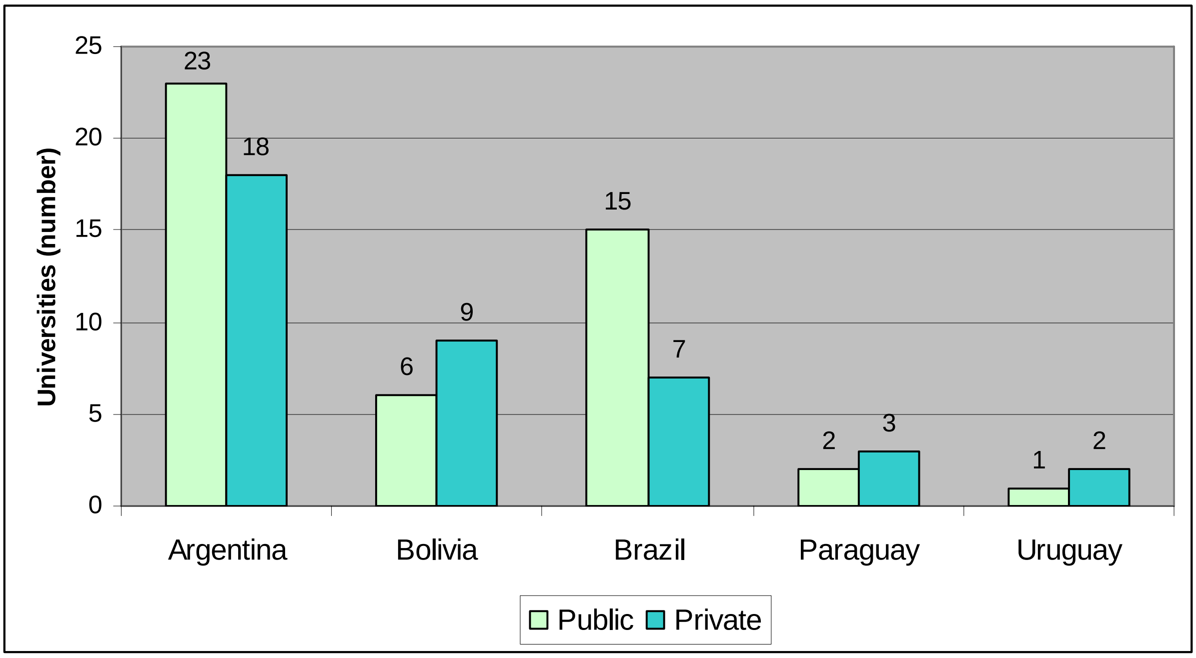
14.1.2. Water sciences in school curriculum

Diverse programmes and courses related with water and environmental issues exist in 86 public and private universities located in the La Plata Basin. Figure 14.2 and Figure 14.3 show the distribution of the 86 universities by country both in absolute and relative terms.

The information about water and environmental issues was collected considering:

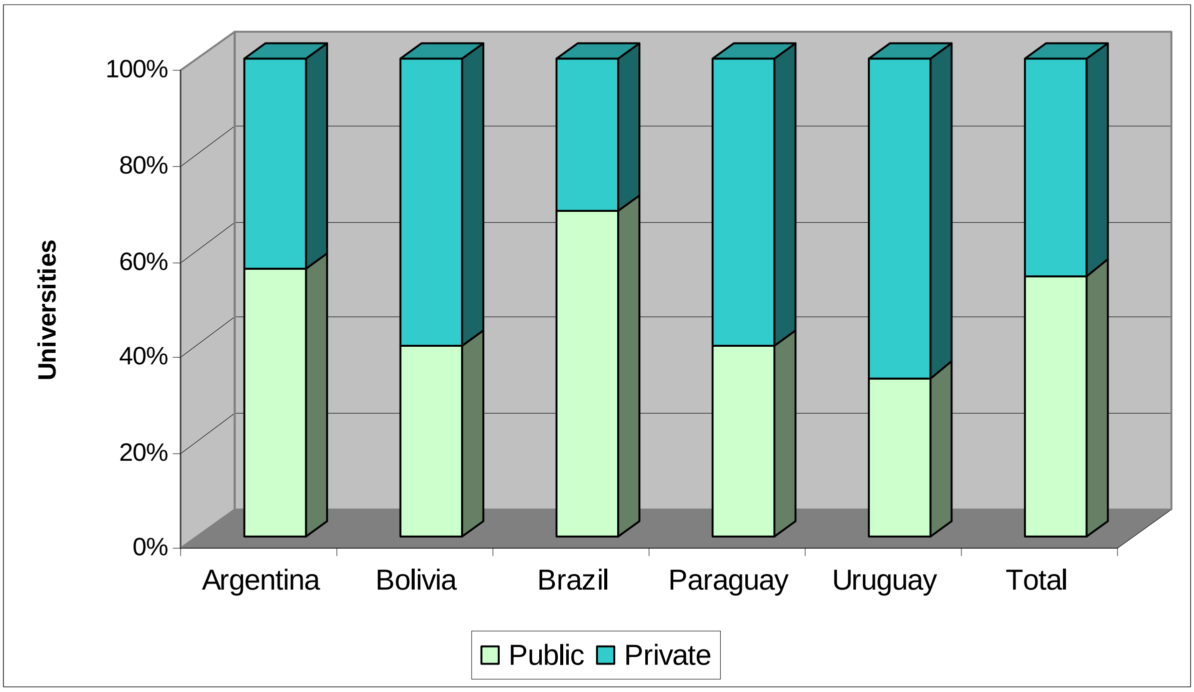
- University
- School / Deparment
- Programme
- Courses (related with water and environmental issues)
- Web page

Figure 14.2. La Plata River Basin. Distribution of Public and Private Universities by country (number)



Source: Web pages of Universities in the La Plata Basin

Figure 14.3. La Plata River Basin. Distribution of Public and Private Universities by country (percentage)



Source: Web pages of Universities in the La Plata Basin

Such information was organised into ten tables, considering the country where the university is located and its type (public or private). The tables are shown below.

14.1.2.1. Argentina

- Public institutions

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
De Buenos Aires	Facultad de Ingeniería (School of Engineering)	Civil Engineering (oriented to Hydraulics)	General Hydraulics. *Optional:* Applied Hydraulics; Environmental Management of Water Resources; Dams. *Specific Hydraulics Courses:* Hydraulic Power Plants; Hydraulic Models; Hydrology; Hydraulic Resources Planning; River and Ocean Hydraulics; Hydraulic Constructions.	http://www.fi.uba.ar/guiaestudiante/civil.php
		Food Engineering	Environmental Management in the Food Industry.	http://www.fi.uba.ar/guiaestudiante/alimentos.php
		Marine and Mechanical Engineering	Ports and Waterways (optional).	http://www.fi.uba.ar/guiaestudiante/naval_mecanica.php
		Chemical Engineering	Environmental and Occupational Safety; Reservoir Engineering Fundamentals (optional).	http://www.fi.uba.ar/guiaestudiante/quimica.php
	Facultad de Agronomía (School of Agronomy)	Agronomy	Agricultural Climatology; Land Conservation and Land Use Planning I; Land Conservation and Land Use Planning II; Ecology; Environmental Impact in Agricultural Systems; Irrigation and Drainage Systems	http://www.agro.uba.ar/carreras/agronomia/plan.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
De Buenos Aires	Facultad de Agronomía (School of Agronomy)	Environmental Sciences	Agricultural Climatology; Agrosystems; Environment and Society; Geographic Information and Remote Detection Systems Applied to Environmental Studies; Aquatic Ecology; Political and Environmental Economics; Argentine Environmental Geography; Hydrology; Introduction to Environmental Sciences Programming; Environmental Risk Analysis; Global Change; Environmental Ethics and Assessment; Environmental Impact Assessment; Natural Resources Management and Conservation; Environmental Sciences Research Methodology. In-Depth Study Courses by specialisation *Technology*: Water Quality and Pollution; Water and Liquid Waste Treatment; *Conservation:* Aquatic System Restoration; *Environmental Policy*: Cultures and Environment; Environmental Awareness and Conflict Resolution; International Environmental Land Arrangement, Law and Policy. *Management:* Fauna and Fishery Resources Management; Integrated Management of Watersheds and Water Resources.	http://www.agro.uba.ar/carreras/ambientales/plan.htm
		Landscape Design and Planning	Climatology and Phenology; Soil and Vegetation Management.	http://www.agro.uba.ar/carreras/paisaje/plan.htm
	Facultad de Arquitectura,	Architecture	Urban Infrastructure and Bioenvironmental Impact (elective).	http://www.fadu.uba.ar/carreras/planes/arq/index.html

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
de Buenos Aires	Diseño y Urbanismo (School of Architecture, Design and Urbanism)	Landscape Design	Climatology and Phenology Ecology.	http://www.fadu.uba.ar/carreras/planes/pai/index.html
	Facultad de Ciencias Exactas y Naturales (School of Exact and Natural Sciences)	Atmosphere Sciences	Synoptic Meteorology; Atmosphere Dynamics I; Climatology; Cloud Convection and Microphysics; *Initial Specialisation Courses:* Fluid Mechanics; General Atmosphere Circulation; Atmosphere Dynamics II; Dynamic Climatology; Local Climatology. *Optional Courses:* Hydrology, Hydrometeorology; Agricultural Meteorology I; Agricultural Meteorology II; Atmospheric Pollution; Advanced Climatology Issues.	http://www.fcen.uba.ar/carreras/licatmos.htm#pla
		Biological Sciences	*Basic Professional Courses:* Ecology – Overview *Higher Professional Courses (optional courses):* Bioclimatology, Climatology, Environmental Ecology; Ecology and Development; Geology and Environmental Ecology in Coastal Areas; Water Chemistry in Natural Sciences.	http://www.fcen.uba.ar/carreras/licbiolo.htm#pla
		Geological Sciences	*Specialisations:* Hydrogeology, Environmental Geology, Applied Geology (studies related to civil works, bridges, dikes, etc.); Coastal and Marine Geology.	http://www.fcen.uba.ar/carreras/licgeolo.htm#pla
		Chemical Sciences	Chemistry of Natural Water Systems (optional).	http://www.fcen.uba.ar/carreras/licquimi.htm#pla
		Food Science and Technology	Environmental Protection and Industrial Hygiene.	http://www.uba.ar/academicos/o_academica/alimentos/index.php

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
de Buenos Aires	Facultad de Ciencias Sociales (School of Social Sciences)	Sociology	*Special Courses:* Social Sciences and Environment.	http://sociologia.fsoc.uba.ar/grilla_plan.htm
	Facultad de Filosofía y Letras (School of Phylosophy and Arts)	Geography	Physical Geography, Ecology and Biogeography *Oriented to Natural Geography:* Climatology; Geomorphology II (climate); Continental Hydrology; Physical Geography of Argentina; Seminar on Hydrogeomorphology; Seminar on Natural Resources; Seminar on Environmental Planning.	http://www.filo.uba.ar/contenidos/carreras/geografia/plan/frameset.html
	Facultad de Derecho (School of Law)	Law	*Specialized Professional Courses:* International Public Law (the programme course includes International Environmental Law).	http://www.derecho.uba.ar/academica/carreras_grado/abogacia_plan2004.php
Nacional de General San Martín	Escuela de Ciencia y Tecnología (School of Science and Technology)	Environmental Analysis	Water Pollution, Measurement, Control and Mitigation Systems (Water Quality Monitoring Systems); Polluted Water Management; Physical, Chemical and Biological Methods for Water and Sludge Treatment and Recovery; Mitigation in Rural Drinking Water Systems; Liquid Waste.	http://www.unsam.edu.ar/webunsam/ecyt/home.php?cmd=viewoffrm&id=74
	Escuela de Economía y Negocios (School of Economy and Business)	Economics		http://www.unsam.edu.ar/webunsam/eeyn/home.php?cmd=viewoffrm&id=12
Nacional de General Sarmiento	---	Urban Ecology	General Ecology; Urban Ecology; Industrial Ecology.	http://www.ungs.edu.ar/carreras.htm#licecol
	---	City Planning	General Ecology; Urban Ecology.	http://www.ungs.edu.ar/carreras.htm#licurb
	---	Industrial Engineering	Industrial Safety and Hygiene; Environment.	http://www.ungs.edu.ar/carreras.htm#ingenieria

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de La Matanza	Facultad de Ingeniería e Inovaciones Tecnológicas (School of Engineering and Technological Innovations)	Industrial Engineering	Ecology and Sustainable Development.	http://www.unlm.edu.ar/home.php?pageid=412&idioma=esp
	Facultad de Derecho y Ciencias Políticas (School of Law and Political Sciences)	Law	Navigation Law. Environmental Law and the Environment.	http://www.unlm.edu.ar/home.php?pageid=1212&plan=1
Nacional de La Plata	Facultad de Ingeniería (School of Engineering)	Hydraulic Engineering	Hydraulics I; Hydraulics II; Hydrology I; Hydrology II; River Hydraulics; Hydromechanics; Irrigation and Drainage; Hydrochemistry and Transportation of Contaminants; Sanitary Engineering; Water Resources Management and Planning; Environmental Management; Hydraulic Projects; Hydraulic Constructions; Ports and Waterways.	http://www.ing.unlp.edu.ar/carreras/text/hidraulica.htm
		Civil Engineering	General Hydraulics I; General Hydraulics II; Hydraulic Works; Environmental Management. *Optional Courses Oriented to Hydraulics:* Hydraulic Infrastructure Works; Hydraulic Projects; Hydromechanical Facilities Projects.	http://www.ing.unlp.edu.ar/carreras/text/civil.htm
		Chemical Engineering	Environmental Engineering Fundamentals *Environmental Orientation:* Environmental Engineering; Water Pollution and Liquid Waste Treatment; Comprehensive Waste Management.	http://www.ing.unlp.edu.ar/carreras/text/quimica.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de La Plata		Engineer in Land Surveying	Environmental Management; Hydrography.	http://www.ing.unlp.edu.ar/carreras/text/agrimensor.htm
	Facultad de Ciencias Agrarias y Forestales (School of Agrarian and Forestry Sciences)	Agronomic Engineering	Agroecology. Irrigation and Drainage.	http://www.agro.unlp.edu.ar/carreras/agrarias/
		Forest Engineering	Forest Ecology; Watershed Management; Irrigation and Drainage.	http://www.agro.unlp.edu.ar/carreras/forestales/
Nacional de La Plata	Facultad de Ciencias Exactas (School of Exact Sciences)	Environmental Chemistry and Technology	Introduction to Environmental Sciences; Environmental Analytical Chemistry; Pollutant Reduction Technologies; Eco-toxicology and Risk Assessment; Biological Treatment for Pollutant Reduction.	http://www.exactas.unlp.edu.ar/carreras/ambiental.htm
	Facultad de Humanidades y Ciencias de la Educación (School of Humanities and Education Sciences)	Geography	Physical Geography I; Physical Geography II; Physical Geography of Argentina; Seminar on Natural Resources Geography and Environmental Policy (optional).	http://www.fahce.unlp.edu.ar/departamentos/deptoge/
	Facultad de Ciencias Jurídicas y Sociales (School of Law and Social Sciences)	Law	Navigation Law (ocean, river and air navigation).	http://www.unlp.edu.ar/index.php?pagina=unidadesacademicas.php&camino=UNIDADES%20ACADEMICAS
	Facultad de Ciencias	Geology	Hydrogeology.	http://www.fcnym.unlp.edu.ar/dependencias/alumnos/geo_detalle.html#544

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
	Naturales y Museo (School of Natural Sciences and Museum)	Biology (Ecology-oriented)	General Ecology; Nature Protection and Conservation.	http://www.fcnym.unlp.edu.ar/dependencias/alumnos/eco_objetivos.htm
	Facultad de Ciencias Económicas (School of Economical Sciences)	Tourism	Economic Growth, Tourism and Environment.	http://www.econo.unlp.edu.ar/academica/turismo.htm
Nacional de Lanús	Departamento de Desarrollo Productivo y Trabajo (Deparment of Productive Development and Work)	Urban Environmental Management	Environment I; Environment II; Ecology Fundamentals; Environment III; Seminar on Environmental Impact Assessment Processes; Environmental Laws; Seminar on Environmental Policy in Argentina and the MERCOSUR; Seminar on Environmental Auditing; Urban Utilities and Sanitation; Environment IV; Seminar on Environmental-City Development Projects.	http://www.unla.edu.ar/licenciaturas/gestinambiental/gestionambiental.php
		Food Science and Technology	The Food Industry and the Environment.	http://www.unla.edu.ar/licenciaturas/alimentos/alimentos.php
		Tourism	Tourism and Ecology.	http://www.unla.edu.ar/licenciaturas/turismo/turismo.php
Nacional de Lomas de Zamora	Facultad de Ingeniería (School of Engineering)	Industrial Engineering	Environmental Engineering.	http://www.fi-unlz.org.ar/planes.htm
		Mechanical Engineering	Environmental Engineering.	http://www.fi-unlz.org.ar/planes.htm
	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Agronomic Engineering	Agroecology; Water Management.	http://www.unlz.edu.ar/agrarias/c-agronom.html
		Animal Breeding Engineering	Ecology and Phytogeography; Agricultural Climatology and Phenology; Aquaculture.	http://www.unlz.edu.ar/agrarias/c-zootecnia.html

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de Lomas de Zamora	Facultad de Derecho (School of Law)	Law	Applicable Natural Resources Laws; Navigation Law.	http://www.unlz.edu.ar/a-derech.htm
Nacional de Luján	Departamento de Tecnología (Department of Technology)	Agronomic Engineering	Ecology; Agricultural Meteorology; Irrigation and Drainage.	http://www.unlu.edu.ar/C_agronomia.htm
		Food Engineering	General Ecology; Sanitation.	http://www.unlu.edu.ar/C_alimentos.htm
		Industrial Engineering	Bioenvironmental Engineering; Pneumatic and Hydraulic Facilities; Environmental and Industrial Safety.	http://www.unlu.edu.ar/C_indust.htm
	Departamento de Ciencias Básicas (Deparment of Basic Sciences)	Biological Sciences	Earth, Water and Atmosphere Sciences; Ecology I. *Ecology-Oriented:* Ecology II; Ecology III.	http://www.unlu.edu.ar/C_biologia.htm
	Departamento de Ciencias Sociales (Department of Social Sciences)	Geography (bachelor's degree)	Seminar on Argentine Geography; Seminar on Geographical Issues.	http://www.unlu.edu.ar/C_geografia.htm
Nacional de Luján	Departamento de Ciencias Sociales (Department of Social Sciences)	Geography (Graduate Teacher Training Programme)	General Ecology; Natural Planetary Processes; Environmental Education.	http://www.unlu.edu.ar/C_prof_geografia.htm
		Environmental Education (Bachelor's degree)	Environmental Geography of Argentina; General Ecology; Environmental Economic Policy; Environmental Law; Environmental Management; Environmental Education; Project Environmental Assessment Methodology; International Environmental Law; Development of Environmental Education Material; Environmental Impact Assessment Methodology; Environmental Land Arrangement; Environmental Geography; Environmental History.	http://www.unlu.edu.ar/C_ambiental.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de Luján	Departamento de Ciencias Sociales (Department of Social Sciences)	Environmental Education (Graduate Technical Degree)	Environmental Geography of Argentina; General Ecology; Environmental Economic Policy; Environmental Law; Environmental Management; Environmental Education; Project Environmental Assessment Methodology.	http://www.unlu.edu.ar/C_ambiental.htm
Nacional de Tres de Febrero	---	Occupational Safety and Health	Environmental Sanitation.	http://www.untref.edu.ar/carreras_de_grado.htm#
	---	Geography (Teacher Supplementary Programmes)	Environmental Geographic Information Systems; Systematic Geography I (Physical Ecogeosystems); Seminar on Physical Ecosystems I (Physics and Ecology); Seminar on Physical Ecosystems II (Physics and Urban Ecology); Seminar on Land and Environmental Management at Local Level.	http://www.untref.edu.ar/complementecion_geografia.htm
Nacional de Quilmes	---	Food Engineering	Environmental Engineering.	http://www.unq.edu.ar/layout/redirect.jsp?idSection=1091
	---	Biotechnology	*Environmental Area:* Public Health and the Environment; Ecotoxicology and Environmental Chemistry; Environmental Laws; Environmental Impact; Solid and Gaseous Waste Treatment.	http://www.unq.edu.ar/layout/redirect.jsp?idSection=1093
Nacional del Centro de la Provincia de Buenos Aires	Facultad de Ingeniería (School of Engineering)	Civil Engineering	General Hydraulics; Hydrology; Hydraulic Works; Sanitary Engineering.	http://www.fio.unicen.edu.ar/contenido/carreras/civil/ingecivil.htm
		Industrial Engineering	Hydraulic and Pneumatic Systems.	http://www.fio.unicen.edu.ar/contenido/carreras/indu/ingeindu.htm
		Engineering in Occupational Safety and Health	Liquid Waste and Waste Material Treatment Pollution.	http://www.fio.unicen.edu.ar/contenido/carreras/seg/seg.htm
	Facultad de Agronomía (School of Agronomy)	Agronomic Engineering	Agricultural Botany I; Agricultural Botany II; Agrometeorology; Agroecology; Soil Management and Conservation; Plant Breeding Water Management.	http://www.faa.unicen.edu.ar/Carreras/Agronomia.html
		Farm Management	Seminar on Ecology and the Environment.	http://www.faa.unicen.edu.ar/Carreras/Licenciatura.html

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
		Teacher Training Programme in Biological Sciences	General Ecology; Environmental Issues; Natural Resources.	http://www.faa.unicen.edu.ar/Carreras/Prof_C_B.html
Nacional del Centro de la Provincia de Buenos Aires	Facultad de Ciencias Exactas (School of Exact Sciences)	Environmental Technology	Introduction to Environmental Issues and Ecology; Basic Concepts of Environmental Law; Ecology Fundamentals; Earth Sciences I; Earth Sciences II; Earth Sciences III; Water and Liquid Waste Pollution Detection; Environmental Economy; Water Quality and Liquid Waste Treatment Processes.	http://www.exa.unicen.edu.ar/carreras/lic_tecn.htm
		Teacher Training Programme in Natural Sciences (for the 3rd stage of general high-school education, EGB3)	Introduction to Environmental Issues and Ecology; Ecology Fundamentals.	http://www.exa.unicen.edu.ar/carreras/prof_fisi3.htm
		Graduate Environmental Monitoring Analyst	Introduction to Environmental Issues and Ecology; Ecology Fundamentals; Basic Concepts of Environmental Law; Earth Sciences I; Water and Liquid Waste Pollution Detection.	http://www.exa.unicen.edu.ar/carreras/ana_moam.htm
Nacional del Centro de la Provincia de Buenos Aires	Facultad de Ciencias Humanas (School of Human Sciences)	Geography (bachelor's degree)	Geography of Natural Systems I; Geography of Natural Systems II; Natural Resources and the Environment.	http://www.fch.unicen.edu.ar/texto_geografia.htm
		Geography (Teacher Training Programme)	Geography of Natural Systems I; Geography of Natural Systems II; Natural Resources and the Environment.	http://www.fch.unicen.edu.ar/texto_geografia.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional del Centro de la Provincia de Buenos Aires	Facultad de Ciencias Humanas (School of Human Sciences)	Environmental Diagnosis and Management	Introduction to Environmental Issues; Introduction to Earth Sciences; Climatology; Ecology, Environmental Regulation and Management; Geomorphology and Natural Hazards; Water Resources; Environmental Policy; Urban Environmental Management Systems; Rural Environmental Management Systems; Environmental Economy; Pollution; Environmental Auditing; Environmental Arrangement of Land; Environmental Impact Assessment.	http://www.fch.unicen.edu.ar/texto_ambiental.htm
		Geographic Information Systems Technician	Geography of Natural Systems I; Geography of Natural Systems II; Natural Resources and the Environment.	http://www.fch.unicen.edu.ar/texto_geografia2.htm
	Facultad de Ciencias Veterinarias (School of Veterinarian Sciences)	Veterinary	*Animal Breeding Module:* Aquaculture (optional). *Aquaculture-Oriented Module*: Limnology and Ecology; Aquaculture Engineering and Water Quality Management; Fishing Biology and Fishing Arts (optional). *Oriented to Food Inspection and Technology:* Food Industry Sanitation.	http://www.vet.unicen.edu.ar/carreras/medveerinaria.htm
Nacional del Litoral	Facultad de Ingeniería y Ciencias Hídricas (School of Engineering and Water Sciences)	Water Resources Engineering	Water Chemistry and Biology; Technology, Environment and Society; Fluid Mechanics; Hydrometeorology; Topography and Hydrometering I and II; Flood Control Hydrology; Groundwater Hydrology; Water-Related Laws; Hydraulic Works; Economic and Environmental Development and Assessment of Projects I and II; Groundwater Development; Irrigation and Drainage; Analysis of Water Systems; Structural Design of Hydraulic Works.	http://fich.unl.edu.ar/carreras/grado_irh

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional del Litoral	Facultad de Ingeniería y Ciencias Hídricas (School of Engineering and Water Sciences)	Environmental Engineering	Technology, Environment and Society; Applied Hydrology; Applied Hydraulics; Ecology; Environmental Microbiology; Physical-Chemical Processes in Environmental Engineering; Biological Processes in Environmental Engineering; Environmental Modelling; Analysis of Environmental Systems; Environmental Modelling; Economic and Environmental Drafting and Assessment of Projects I and II; Risk Analysis and Environmental Law.	http://fich.unl.edu.ar/carreras/grado_ia
Nacional del Litoral	Facultad de Ingeniería y Ciencias Hídricas (School of Engineering and Water Sciences)	Engineering in Land Surveying	Physical Geography.	http://fich.unl.edu.ar/carreras/grado_iag.htm
		Bachelor's degree in Cartography	Physical Geography.	http://fich.unl.edu/ar/carreras/grado_lc.htm
	Facultad de Ingeniería Química (School of Chemical Engineering)	Bachelor's degree in Food Science and Technology (Short graduate specialisation programme certificate)	Liquid Waste Treatment.	http://www.fiqus.unl.edu.ar/ofertas/carreras/ia.htm
	Facultad de Bioquímica y Ciencias Biológicas (School of Biochemistry and Biological Sciences)	Graduate Sanitation Technician (intermediate degree)	General Geohydrology; Sanitation I; Sanitation II; Sanitation III; Sanitation IV; Sanitation V; Sanitation VI.	http://www.fbcb.unl.edu.ar/academic/tec_sa.htm
		Environmental Sanitation (Bachelor's degree)	General Geohydrology; Sanitation I; Sanitation II; Sanitation III; Sanitation IV; Sanitation V; Sanitation VI; General Ecology, Water Sanitation; Environmental Impact Assessment.	http://www.fbcb.unl.edu.ar/academic/lic_sam.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional del Litoral	Facultad de Bioquímica y Ciencias Biológicas (School of Biochemistry and Biological Sciences)	Occupational Safety and Health	General Geohydrology; Sanitation I; Sanitation II; Sanitation III; Sanitation IV; Sanitation V; Sanitation VI; Environmental Health Laws.	http://www.fbcb.unl.edu.ar/academic/lic_hyst.htm
	Facultad de Ciencias Agrícolas (School of Agricultural Sciences)	Agronomic Engineering	Agrometeorology; Water Diagnosis and Technology; Ecology.	http://www.fca.unl.edu.ar
	Facultad de Ciencias Veterinarias (School of Veterinarian Sciences)	Veterinary Medicine	(Oriented to Public Health): Environmental Sanitation; Seminar on Ecology.	www.fcv.unl.edu.ar/Archivo/objetivos
	Facultad de Humanidades y Ciencias (School of Humanities and Sciences)	Bachelor's Degree in Geography	Climatology; Biogeography.	http://www.fhuc.unl.edu.ar/html/carr_licgeo.htm
		Teacher Training Programme in Geography	Climatology; Biogeography.	http://www.fhuc.unl.edu.ar/html/carr_geo.htm
		Teacher Training Programme in Biology	General Ecology; Biogeography	http://www.fhuc.unl.edu.ar/html/carr_profbio.htm
		Biodiversity	General Ecology; Environmental Management.	http://www.fhuc.unl.edu.ar/html/carr_licbiod.htm#plan

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional del Litoral	Facultad de Ciencias Económicas (School of Economical Sciences)	Economics	*Specialised Education Programme:* Environmental Economics.	http://www.fce.unl.edu.ar/le/index.htm
	Facultad de Ciencias Jurídicas y Sociales (School of Law and Social Sciences)	Law	Environmental Law (optional).	http://www.fcjs.unl.edu.ar/Carreras/DeGrado/planestudioabogacia.htm
Nacional de Rosario	Facultad de Ciencias Exactas, Ingeniería y Agrimensura (School of Exact Sciences, Engineering and Surveying)	Civil Engineering	Water Resources I; Water Resources II; Water Resources III; Environmental and Sanitary Engineering; Development and Hydraulic Works.	http://www.fceia.unr.edu.ar/labinfo/info_academica/carreras/civil/civil.html
	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Agronomic Engineering	Agricultural Climatology; Plant Ecology.	http://www.fcagr.unr.edu.ar/
Nacional de Entre Ríos	Facultad de Ciencias Agropecuarias (School of Agricultural and Livestock Sciences)	Agronomic Engineering	Agroclimatology; Agricultural Climatology; Irrigation and Drainage.	http://www.uner.edu.ar/academicas/contenedor_mainframe_ingenieria.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de Entre Ríos	Facultad de Ciencias de la Salud (School of Health Sciences)	Environmental Health	Environmental Law; Water and Sewage Sanitation I; Household Hygiene; Urban Refuse Collection and Solid Waste; Environmental Pollution; Vector Control; Disasters; Hazardous Waste; Water Pollution; Water and Sewage Sanitation II; Environmental Economics; Environmental Law II; Environmental Assessment; Environmental Impact Assessment; Sustainable Development.	http://www.fcs.uner.edu.ar/salud/salud.htm
		Environmental Health Technician	Environmental Law; Water and Sewage Sanitation I; Environmental Pollution; Vector Control; Disasters.	http://www.fcs.uner.edu.ar/
Nacional del Nordeste	Facultad de Ingeniería (School of Engineering)	Civil Engineering	Planning; General Hydraulics; Hydrology; Sanitary and Environmental Engineering; Development and Hydraulic Works. *Specialised in Hydraulics:* Irrigation and Drainage; Hydraulic Constructions; Hydraulic Machinery; Optional courses: Bridges; Environmental Impact of Hydraulic Works; Flood Control Hydraulics; Water Resource Systems Optimisation.	http://ing.unne.edu.ar/carreras/ingcivil98.htm
		Technical Degree in Environmental Education	Climate Components and Processes; Environmental Hydrology; Ecosystem Biotic Components.	http://ing.unne.edu.ar/pub/tuia.pdf
		Teacher Training Programme in Engineering Sciences	Specialised in Hydraulics	http://ing.unne.edu.ar/pub/carerra_cs_ing.pdf
Nacional del Nordeste	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Agronomic Engineering	Agroclimatology; Agricultural Hydrology; Natural Resources.	http://agr.unne.edu.ar/academica.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional del Nordeste	Facultad de Ciencias Exactas, Naturales y Agrimensura (School of Exact and Natural Sciences and Surveying)	Biological Sciences (Botany-Oriented)	Ecology; Plant Ecology. Optional: Climatology; Community Ecology; Natural Resources Management.	http://www.exa.unne.edu.ar/grado/carrera.php?carrera=16
		Biological Sciences (Paleontology-Oriented)	Ecology; Paleobiogeography. Optional: Climatology; Natural Resources Management.	http://www.exa.unne.edu.ar/grado/carrera.php?carrera=5
		Biological Sciences (Zoology-Oriented)	Ecology. Optional: Climatology; Natural Resources Management.	http://www.exa.unne.edu.ar/grado/carrera.php?carrera=15
		Biological Sciences (Genetics-Oriented)	Ecology. Optional: Climatology; Natural Resources Management.	http://www.exa.unne.edu.ar/grado/carrera.php?carrera=14
		Teacher Training Programme in Biology	Ecology; Health and Environmental Education.	http://www.exa.unne.edu.ar/grado/carrera.php?carrera=12
		Land Surveying	Hydraulic Surveying (optional).	http://www.exa.unne.edu.ar/grado/carrera.php?carrera=1
		Teacher Training Programme in Chemical and Environmental Sciences	Ecology and Environment.	http://www.exa.unne.edu.ar/grado/carrera.php?carrera=9
	Facultad de Humanidades (School of Humanities)	Geography	Climatology; Marine and Continental Hydrography; Biogeography and Environmental Geography.	http://www.hum.unne.edu.ar/academica/carreras/geografia.pdf

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional del Nordeste	Facultad de Ciencias Jurídicas y Sociales (School of Law and Social Sciences)	Law	Navigation and Customs Law; Seminar on Natural Resources and the Environment.	http://www.dch.unne.edu.ar/apn.htm
Nacional de Misiones	Facultad de Ingeniería (School of Engineering)	Civil Engineering		http://www.fiobera.unam.edu.ar/modules.php?name=Departamentos
	Facultad de Ciencias Forestales (School of Forest Sciences)	Forest Engineering	Ecology; Hydrology.	http://www.facfor.unam.edu.ar/academica/ingfor.htm
		Wood Industry Engineering	Industry, Society and Environment.	http://www.facfor.unam.edu.ar/academica/ingmad.htm
		University Park Ranger Technician	Environmental Education I and II; Natural Areas Protection and Management; Ecodevelopment; Landscape Ecology.	http://www.facfor.unam.edu.ar/academica/tug.htm
		Teacher Training Programme in Biology	Environmental Issues.	http://www.facfor.unam.edu.ar/academica/pbiol.htm
	Facultad de Ciencias Exactas, Químicas y Naturales (School of Exact, Chemical and Natural Sciences)	Chemical Engineering	Environmental and Industrial Quality Management; Human Beings, Nature and Society. *Oriented to Environmental Engineering:* Introduction to Environmental Engineering; Environmental and Health Technology; Environmental Management and Protection.	http://www.fceqyn.unam.edu.ar/carreras/ingquimica/descripcion.html
		Teacher Training Programme in Biology	Environmental Issues; General Ecology.	http://www.fceqyn.unam.edu.ar/carreras/profbiologia/descripcion.html
Nacional de Formosa	Facultad de Recursos Naturales (School	Civil Engineering	Fluid Mechanics; Water Resources I; Water Resources II; Water Resources III; Sanitary and Environmental Engineering.	http://www.unf.edu.ar/portal/recursosnat.php#

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
	of Natural Resources)	Forest Engineering	Meteorology and Climatology; Ecology and Human Environment; General Hydraulics and Torrent Control.	http://www.unf.edu.ar/portal/recursosnat.php#
		Agribusiness Technician	Agricultural and Aquaculture Inputs and Products.	http://www.unf.edu.ar/portal/recursosnat.php#
		Animal Breeding Engineering	General Ecology; Climatology and Phenology.	http://www.unf.edu.ar/portal/recursosnat.php#
Nacional de Formosa	Facultad de Humanidades (School of Humanities)	Teacher Training Programme in Biology	Health and Environmental Education; Ecology.	http://www.unf.edu.ar/portal/rhumanos.php
		Geography (Teacher Training Programme and Bachelor's Degree).	Climatology; Continental and Marine Hydrology; Natural Resources Policy and Economics.	http://www.unf.edu.ar/portal/rhumanos.php
		Geography (Bachelor's Degree, Interrelated Courses)	Seminar on Environment and Society.	http://www.unf.edu.ar/portal/rhumanos.php
Nacional de Río Cuarto	Facultad de Ciencias Exactas, Físico-Químicas y Naturales (School of Exact, Physical-Chemical and Natural Sciences)	Biology	General Ecology.	http://intra.exa.unrc.edu.ar/carreras/licenciatura.html#1
		Geology (Environmental Orientation)	Climate, Introduction to Environmental Sciences; Environmental Geology; Geohydrology; Natural Resources Management; Environmental Laws; Environmental Impact Assessment.	http://intra.exa.unrc.edu.ar/carreras/licenciatura.html#4
		Teacher Training Programme in Biological Sciences	General Ecology. Environmental Education.	http://intra.exa.unrc.edu.ar/carreras/profesorado.html#1

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de Río Cuarto	Facultad de Ciencias Humanas (School of Human Sciences)	Geography (Teacher Training Programme and Bachelor's Degree)	Climatology and Continental Hydrology; Biogeography and Ecology; Natural Resources Policy and Economics; Geography of the Natural Environment in Argentina.	http://www.unrc.edu.ar/insti/geograf.htm
	Facultad de Agronomía y Veterinaria (School of Agronomy and Veterinary)	Agronomic Engineering	Introduction to Agricultural Meteorology; Plant Ecology; Agrometeorology I and II; Soil Use and Management; Agricultural Hydrology.	http://www.ayv.unrc.edu.ar/Ingenieria_agronomica.htm
Nacional de Córdoba	Facultad de Ciencias Exactas, Físicas y Naturales (School of Exact, Physical and Natural Sciences)	Civil Engineering	Fluid Mechanics; Hydrology and Hydraulic Processes; Sanitary Engineering; Hydraulic Works.	http://www.efn.unc.edu.ar/grado.html
		Mechanical Engineering	Fluid Mechanics; Environmental Management.	http://www.efn.unc.edu.ar/grado.html
		Land Surveying	Topography II and Hydrography; Physical Geography.	http://www.efn.unc.edu.ar/grado.html
		Geological Sciences	General Hydrology; Hydrogeology; Environmental Geology, Hygiene and Safety	http://www.efn.unc.edu.ar/grado.html
		Biological Sciences	Environmental Issues. *Optional:* Natural Resources Management; Workshop on Plants and Environment in Watersheds; Workshop on Ecology of Ichthyological Communities; Sustainable Use of Natural Resources; Workshop on Freshwater Aquaculture; Applied Hydrobiology; Fishery Biology.	http://www.efn.unc.edu.ar/grado.html

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de Córdoba	Facultad de Ciencias Agropecuarias (School of Agricultural and Livestock Sciences)	Agronomic Engineering	Agricultural Hydrology; Agricultural Ecology.	http://www.agro.uncor.edu/lafacu.htm
	Facultad de Derecho y Ciencias Sociales (School of Law and Social Sciences)	Law	Farm, Mining and Environmental Law.	http://www.derecho.unc.edu.ar/
Nacional de Tucumán	Facultad de Ciencias Exactas y Tecnología (School of Exact Sciences and Technology)	Civil Engineering	Courses related to water resources issues.	http://www.herrera.unt.edu.ar/facet/academico/carreras.htm
		Industrial Engineering	Environmental Engineering.	http://www.herrera.unt.edu.ar/facet/academico/carreras.htm
		Geodetic and Geophysical Engineering	Courses related to water resources issues.	http://www.herrera.unt.edu.ar/facet/academico/carreras.htm
	Facultad de Agronomía y Zootecnia (School of Agronomy and Animal Breeding)	Agronomic Engineering	Ecology Overview.	http://www.manant.unt.edu.ar/estudiantiles/estagro.htm
		Animal Breeding Engineering	Agricultural Climatology and Phenology.	http://www.manant.unt.edu.ar/estudiantiles/estzoot.htm
		Graduate Agroindustry Technician	Environmental Quality.	http://www.manant.unt.edu.ar/estudiantiles/2005_tec.htm
Nacional de Tucumán	Facultad de Ciencias	Geology	Hydrogeology.	http://www.csnat.unt.edu.ar/carreras/geo.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de Tucumán	Naturales e Instituto Miguel Lillo (School of Natural Sciences and Institute Miguel Lillo)	Biology	Conservation Biology; Landscape Ecology.	http://www.csnat.unt.edu.ar/carreras/biol.htm
		Teacher Training Programme in Biology	General Ecology.	http://www.csnat.unt.edu.ar/carreras/profes.htm
	Facultad de Filosofía y Letras (School of Phylosophy and Arts)	Geography (Teacher Training Programme and Bachelor's Degree)	Natural Systems Geography II (Climatology); Geography of Argentina.	http://www.filo.unt.edu.ar/alumno/alumnos_geog_licenciatura.htm
Nacional de Jujuy	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Agronomic Engineering	Climatology; Agricultural Ecology; General Ecology; Soil and Irrigation Technology.	http://www.fca.unju.edu.ar/htm/planagronomia
		Biological Sciences		http://www.fca.unju.edu.ar/htm/planprofbiologia
	Facultad de Ingeniería (School of Engineering)	Chemical Engineering		http://fi.unju.edu.ar
		Industrial Engineering		http://fi.unju.edu.ar
		Geological Sciences		http://fi.unju.edu.ar
		Food Technology		http://fi.unju.edu.ar
Tecnológica Nacional	Facultad Regional Buenos Aires (Buenos Aires Regional School)	Civil Engineering	General and Applied Hydraulics; Sanitation and Environment; Hydrology and Hydraulic Works; Ports and Waterways; Bridges.	http://carreras.frba.utn.edu.ar/p/
		Mechanical Engineering	Environmental Safety and Health; Fluid Transportation via Tubings (optional).	http://carreras.frba.utn.edu.ar/s/

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Tecnológica Nacional	Facultad Regional Buenos Aires (Buenos Aires Regional School)	Marine Engineering	Navigation.	http://carreras.frba.utn.edu.ar/u_index.html
		Industrial Engineering	Environmental Safety, Health and Engineering.	http://carreras.frba.utn.edu.ar/i/
		Chemical Engineering	*Environmental Orientation:* Environmental Management and Technology I; Environmental Management and Technology II.	http://carreras.frba.utn.edu.ar/quimica/
	Facultad Regional Haedo (Haedo Regional School)	Mechanical Engineering	Environmental Engineering and Industrial Safety; Fluid Mechanics; Hydraulic and Pneumatic Oil Conduits.	http://www.frh.utn.edu.ar/carreras/index
	Facultad Regional General Pacheco (General Pacheco Regional School)	Civil Engineering	General and Applied Hydraulics; Sanitation and Gas Facilities; Sanitary Engineering.	http://www.frgp.utn.edu.ar/carreras/ing_civ/index.htm
		Mechanical Engineering	Environmental Safety, Health and Engineering; Fluid Mechanics.	http://www.frgp.utn.edu.ar/carreras/ing_mec/index.htm
	Facultad Regional Delta (Delta Regional School)	Chemical Engineering	Environmental Engineering (elective).	http://www.frd.utn.edu.ar/?opc=IngenieriaQuimica
		Mechanical Engineering	Environmental Engineering and Environmental Safety; Fluid Mechanics and Thermodynamics.	http://www.frd.utn.edu.ar/?opc=IngenieriaMecanica
	Facultad Regional Venado Tuerto (Venado Tuerto Regional School)	Civil Engineering	General and Applied Hydraulics; Sanitation and Gas Facilities; Hydrology and Hydraulic Works; Sanitary Engineering; Water Resources Use and Hydraulic Construction Works (elective).	http://www.frvt.utn.edu.ar/civil.html
	Facultad Regional Rosario (Rosario Regional School)	Civil Engineering	Courses related to water resources.	http://www.frro.utn.edu.ar/new/carreras/ic/index.php
		Mechanical Engineering	Courses related to environmental pollution.	http://www.frro.utn.edu.ar/new/carreras/im/index.php
		Chemical Engineering	Courses related to environmental pollution.	http://www.frro.utn.edu.ar/new/carreras/iq/index.php

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Tecnológica Nacional	Facultad Regional Santa Fe (Santa Fe Regional School)	Civil Engineering	*Oriented to Construction Works:* Environmental Management and Impact; Hydrology and Hydraulic Works; Sanitation and Gas Facilities; Sanitary Engineering. *Oriented to Communication Routes:* Environmental Management and Impact; Hydrology and Hydraulic Works; Sanitation and Gas Facilities; Sanitation and Environment.	http://www.frsf.utn.edu.ar/index.php?id=64
		Industrial Engineering	Liquid Waste Treatment (elective).	http://www.frsf.utn.edu.ar/index.php?id=64
	Facultad Regional Rafaela (Rafaela Regional School)	Civil Engineering	General and Applied Hydraulics; Sanitation and Gas Facilities; Sanitary Engineering.	http://www.frra.utn.edu.ar/general.php?archivo=carreras/carreras.php
		Industrial Engineering	Environmental Safety, Health and Engineering.	http://www.frra.utn.edu.ar/general.php?archivo=carreras/carreras.php
	Facultad Regional Paraná (Paraná Regional School)	Civil Engineering	*Core Courses:* General and Applied Hydraulics; Sanitation and Gas Facilities. *Specialisation in Construction:* Hydrology and Hydraulic Works; Sanitary Engineering. *Specialisation in Communication Routes:* Hydrology and Hydraulic Works; Ports and Communication Routes.	http://www.utnparana.com.ar/archivos%20comunes/plan_civil.htm
	Facultad Regional Concepción del Uruguay (Concepción del Uruguay Regional School)	Civil Engineering	General and Applied Hydraulics; Sanitation and Gas Facilities; Hydrology and Hydraulic Works; Sanitary Engineering; River and Marine Works.	http://www.frcu.utn.edu.ar/carrera.php?lang=1&id_carrera=O&id_depto=1&id_area=O

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Tecnológica Nacional	Unidad Académica Concordia (Concordia Academic Unit)	Civil Engineering	General and Applied Hydraulics; Hydrology; Hydraulic Works; Sanitation and Environment; Sanitary Engineering.	http://www.uac.utn.edu.ar/carrerasdegrado.php
	Facultad Regional Villa María (Villa María Regional School)	Mechanical Engineering	Environmental Engineering and Industrial Safety; Fluid Mechanics.	http://www.frvm.utn.edu.ar/menu/carreras/carreras_de_grado/mecanica.php?idcarrera=3
	Facultad Regional Resistencia (Resistencia Regional School)	Chemical Engineering	*Electives:* Human and Natural Resources Distribution and Dynamics; Environmental Impact Assessment.	
	Facultad Regional Tucumán (Tucumán Regional School)	Civil Engineering		http://www.frt.utn.edu.ar/civil/
		Mechanical Engineering		http://www.frt.utn.edu.ar/mecanica/

Universidad Nacional de Salta: This University's online service was not working when preparing this report.

- Private Institutions

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Abierta Interamericana	Arquitectura (Architecture)	Architecture	Ecology and Environment.	http://www.vaneduc.edu.ar/uai/facultad/arquitec/fac-arq-carrera.asp
	Derecho (Law)	Law	Ecology and Natural Resources Law; Navigation Law.	http://www.vaneduc.edu.ar/uai/facultad/derecho/fac-dere-carreras.asp

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Argentina John F. Kennedy	---	Bachelor's Degree in Chemistry	Ecology and Environment; Environmental Analytical Chemistry; Environmental and Urban Geology.	http://www.kennedy.edu.ar/escuelas.htm
	----	Bachelor's Degree in International Relations	Environmental Policy and Applicable Laws.	http://www.kennedy.edu.ar/escuelas.htm
Argentina de la Empresa	Facultad de Ingeniería y Ciencias Exactas (School of Engineering and Exact Sciences)	Food Engineering	Health, Safety and Environment.	http://www.uade.edu.ar/FRSET_HOME.asp?vPAG=HOME.asp
		Industrial Engineering	Health, Safety and Environment; Hydraulic Machinery and Thermohydraulic Conduits.	http://www.uade.edu.ar/FRSET_HOME.asp?vPAG=HOME.asp
	Facultad de Ciencias Sociales (School of Social Sciences)	Law	Ecology Law; Navigation and Aeronautics Law.	http://www.uade.edu.ar/FRSET_HOME.asp?vPAG=HOME.asp
Argentina Austral	Facultad de Ingeniería (School of Engineering)	Industrial Engineering	Fluid Mechanics.	http://www.austral.edu.ar/ingenieria/index.htm
	Facultad de Derecho (School of Law)	Law	Environmental Law; Navigation and Aeronautics Law (optional).	http://www.austral.edu.ar/derecho/abogacia/#
Pontificia Católica Argentina	Facultad de Ciencias Fisicomatemáticas e Ingeniería (sede Buenos Aires)	Civil Engineering	General Hydraulics; Applied Hydraulics; Sanitary and Environmental Engineering.	http://www2.uca.edu.ar/esp/sec-fingenieria/esp/page.php?subsec=grado&page=ing-civil&data=ing-civil-perfil

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Pontificia Católica Argentina	Facultad de Ciencias Fisicomatemáticas e Ingeniería, sede Buenos Aires (School of Physic-matemathical Sciences and Engineering, Buenos Aires)	Environmental Engineering	Environmental Sampling and Assessment; Environmental Chemistry; Environmental Engineering; Environmental Management I; Hydrology; Fluid Mechanics; Contaminant Transportation Models; Environment and Technology; Industrial Waste and Urban Refuse; Environmental Management II; Environmental Law, Policy and Regulations; Sanitary Engineering.	http://www2.uca.edu.ar/esp/sec-fingenieria/esp/page.php?subsec=grado&page=ing-ambiental&data=ing-ambiental-perfil
		Industrial Engineering	Fluid Mechanics; Environmental Management.	http://www2.uca.edu.ar/esp/sec-fingenieria/esp/page.php?subsec=grado&page=ing-industrial&data=ing-industrial-perfil
	Facultad de Derecho, sede Buenos Aires (School of Law, Buenos Aires)	Law	Natural Resources Law and Environmental Law (optional, Module B); Navigation Law (optional, Module D).	http://www2.uca.edu.ar/esp/sec-fderecho/esp/page.php?subsec=grado
	Facultad de Derecho, regional Paraná (School of Law, Paraná Regional)	Law	Natural Resources Law and Environmental Law (optional, Module B); Navigation Law (optional, Module D).	http://www2.uca.edu.ar/esp/sec-fderecho-par/esp/page.php?subsec=grado
	Facultad de Derecho y Ciencias Sociales del Rosario (School of Law and Social Sciences of Rosario)	Law	Navigation Law (optional).	http://www.ucaderecho.org/Web/carreras.html
	Facultad Católica de Química e	Environmental Engineering		http://www.bacon.org.ar/ambiente.php

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Pontificia Católica Argentina	Ingeniería Fray R. Bacon, Rosario (Catholic School of Chemistry and Engineering Fray R. Bacon, Rosario)	Bachelor's Degree in Environmental Sciences	Courses are not specified.	http://www.bacon.org.ar/ambiente.php
		Graduate Environmental Analyst	Courses are not specified.	http://www.bacon.org.ar/ambiente.php
		Industrial Engineering	Courses are not specified.	http://www.bacon.org.ar/industrial.php
		Bachelor's Degree in Industrial Chemistry	Courses are not specified.	http://www.bacon.org.ar/quimica.php
		Bachelor's Degree in Food Technology	Courses are not specified.	http://www.bacon.org.ar/licalimentos.php
Católica de Salta	Facultad de Ingeniería e Informática (School of Engineering and Informatics)	Civil Engineering	General Hydraulics; Hydrology.	http://www.ucasal.net/ingenieria/index.htm
		Industrial Engineering	Environmental Engineering.	http://www.ucasal.net/ingenieria/index.htm
	Facultad de Economía y Administración (School of Economy and Administration)	Bachelor's Degree in Agricultural Management	Ecology and Environment.	http://www.ucasal.net/empresas/index.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Católica de Salta	Sistema de Educación a Distancia (Distance Education System)	Law	Natural Resources.	http://www.ucasal.net/sead/
Católica de Santa Fe	Facultad de Ingeniería, Geoecología y Medio Ambiente (School of Engineering, Geo-ecology and Environment)	Environmental Engineering	Introduction to Geoecology and Environment; Integrated Natural Systems; Fluid Mechanics; Water Resources; Environmental Physicochemistry; Industrial Waste and Urban Refuse; Environmental Policy and Law; Health and Environmental Education; Environmental Pollution and Transportation of Contaminants; Sanitary Engineering; Environmental Impact Assessment; Environmental Management and Auditing; Environmental Education and Society.	http://www.ucsf.edu.ar/figma/CARRERA1a.htm
		Bachelor's Degree in Geoecology and Environment	Introduction to Geoecology and Environment; Integrated Natural Systems; Environmental Impact Assessment Techniques; Health and Environmental Education; Natural Hazards and Protection of Integrated Natural Systems.	http://www.ucsf.edu.ar/figma/CARRERA3a.htm
		University Technician in Environmental Assessment	Introduction to Geoecology and Environment; Environmental Chemistry and Physicochemistry; Contaminant Transportation Systems; Health and Environmental Education; Integrated Natural Systems; Environmental Health and Safety; Industrial Waste and Urban Refuse; Environmental Sampling and Assessment.	http://www.ucsf.edu.ar/figma/CARRERA5a.htm
	Facultad de Derecho (School of Law)	Law	Environmental Law.	http://www.ucsf.edu.ar/derecho/CARRERA1a.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
Centro de Altos Estudios en Ciencias	Departamento de Ciencias Biológicas (Deparment of Biological Sciences)	Bachelor's Degree in Environmental Management	Environmental Chemistry; Ecology I and II; Environmental Microbiology; Environmental Issues I and II; Environmental Law; Biological Diversity; Environmental Education; Natural Resources Management; Environmental Economics; Waste Management; Environmental Impact; Environmental Policy; Water Resources; Energy and Environment; Global Climate Change; Environmental Responsibility and Risk; Environmental Impact Study; Environmental Auditing; Sustainable Development.	http://www.caece.edu.ar/biologia.asp
		Graduate Technical Degree in Biodiversity Management, Handling and Conservation	Environmental Education; Biogeography; General Ecology; Environmental Impact.	http://www.caece.edu.ar/Grado/biologia2.asp
	Departamento de Humanidades (Deparment of Humanities)	Bachelor's Degree in Tourism	Tourism and Environment.	http://www.caece.edu.ar/Grado/turismo.asp
		Bachelor's Degree in Biology Teaching	Environmental Education; Ecology and Natural Resources.	http://www.caece.edu.ar/Profesores/lic-biol.html
		Bachelor's Degree in Geography	Environmental Education; Natural Resources.	http://www.caece.edu.ar/Profesores/lic-geog.html
de Belgrano	Facultad de Ingeniería y	Civil Engineering	General Hydraulics; Environmental Management; Hydraulics and Applied Hydrology.	http://www.ub.edu.ar/facultades/IngTecInf/801.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
De Belgrano	Tecnología Informática (School of Engineering and Informatic Technology)	Environmental Engineering	Environmental Engineering I; Environmental Engineering II; Hydraulics and Hydraulic Control; Ground Fluids; Environmental Impact Assessment; Environmental Safety; Environmental Laws; Environmental Economics; Environmental Geotechnics; Applied Hydrology and Environmental Geochemistry.	http://www.ub.edu.ar/facultades/IngTecInf/805.htm
		Industrial Engineering	General Ecology; Environmental Management.	http://www.ub.edu.ar/facultades/IngTecInf/808.htm
	Facultad de Ciencias Exactas y Naturales (School of Exact Sciences and Technology)	Bachelor’s Degree in Biology	Biogeography and Ecology; Environmental Impact Study.	http://www.ub.edu.ar/facultades/Exactas/1402.htm
	Facultad de Derecho y Ciencias Sociales (School of Law and Social Sciences)	Law	Environmental Law (optional).	http://www.ub.edu.ar/facultades/derecho/101.htm
	Facultad de Ciencias Económicas (School of Economics Sciences)	Bachelor’s Degree in Economics	Ecology (optional).	http://www.ub.edu.ar/facultades/Economicas/302.htm
de Morón	Facultad de Agronomía y Ciencias Agroalimentarias	Agronomic Engineering	Agricultural Climatology and Phenology; Ecology; Agricultural Hydrology; Environmental Impact in Agrosystems.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/agronomia/carreras.aspx

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
de Morón	Facultad de Agronomía y Ciencias Agroalimentarias (School of Agronomy and Agro-food Sciences)	Food Engineering	Safety and Health (Industrial and Environmental).	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/agronomia/carreras.aspx
	Facultad de Ciencias Aplicadas al Turismo y la Población (School of Sciences Applied to Tourism and Population)	Bachelor's Degree in Geography (Bachelor's degree Courses)	Environmental Policy; Natural Resources Prospecting and Assessment; Environmental Impact Assessment.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/exactas/carreras.aspx
	Facultad de Ciencias Exactas, Químicas y Naturales (School of Exact, Chemical and Natural Sciences)	Bachelor's degree in Biology	Ecology I; Ecology II; Environmental Ecology.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/exactas/carreras.aspx
		Bachelor's Degree in Ecology	Ecology I and II; Environmental Ecology; Environmental Laws; Environmental Toxicology; Environmental Management; Environmental Impact.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/turismo/carreras.aspx
		Graduate Technician in Ecology and Environmental Control	Ecology I and II; Environmental Ecology; Environmental Laws; Environmental Toxicology; Liquid Waste and Refuse Treatment.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/turismo/carreras.aspx
	Facultad de Ingeniería (School of Engineering)	Civil Engineering	Ecology and Environmental Control; Hydraulics; Hydrology and Hydraulic Works.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/ingenieria/carreras.aspx

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
de Morón	Facultad de Ingeniería (School of Engineering)	Industrial Engineering	Ecology and Environmental Control; Environmental Engineering.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/ingenieria/carreras.aspx
	Facultad de Agronomía y Ciencias Agroalimentarias (School of Agronomy and Agro-food Sciences)	Agronomic Engineering	Ecology; Agricultural Hydrology; Environmental Impact in Agrosystems.	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/agronomia/carreras.aspx
	Facultad de Derecho, Ciencias Políticas y Sociales (School of Law, Political and Social Sciences)	Law	Environmental Law and Natural Resources (optional).	http://www.unimoron.edu.ar/espa/informacion/academica/facultades/derechos/carreras.aspx
del Salvador	Facultad de Ciencia y Tecnología (School of Science and Technology)	Industrial Engineering	Environmental Management; Fluid Mechanics.	http://www.salvador.edu.ar/cytc/facyt/frame-facyt.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
del Salvador	Facultad de Filosofía, Historia y Letras (School of Phylosophy, History and Arts)	Bachelor's Degree in Environmental Sciences	Special Techniques for Pollution Prevention, Control and Sanitation; Environmental Education and Interpretation Methods; Environmental Law and Policy Aspects; Environmental Management; Environmental Geology; Environmental Law and Regulations; Environmental Economics; International Cooperation for Environmental Issues; Satellite Information Applied to the Environment; Environmental Auditing; Environmental Impact Assessment and Control – Monitoring and Auditing; Sustainable Development.	http://www.postgradosusal.com/grado/home.asp
		Bachelor's Degree in Tourism	Ecology and Environment.	http://www.postgradosusal.com/grado/home.asp
		Bachelor's Degree in Geography	Meteorology and Climatology; Environmental Physics; Environmental Geography; Hydrology.	http://www.salvador.edu.ar/fhyl/
	Facultad de Agronomía (School of Agronomy)	Agronomic Engineering	Agricultural Climatology; Ecology; Irrigation and Drainage.	http://www.salvador.edu.ar/agronomia/
		Forest Engineering (classes are conducted in Corrientes)	Agricultural Climatology; Ecology; Irrigation and Drainage.	http://www.postgradosusal.com/grado/home.asp
de Concepción del Uruguay	Facultad de Arquitectura y Urbanismo (School of Architecture and Urbanism)	Bachelor's Degree in Environmental Sciences	Landscaping Ecology; Environmental Design; Environmental Laws; Environmental Conditioning.	http://www.ucu.edu.ar/licenciado_en_dis_ambiente.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
de Concepción del Uruguay	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Graduate Technical Degree in Food Science and Food Manufacturing	Ecology; Environmental Laws.	http://www.ucu.edu.ar/licenciado_en_bromatologia.htm
	Facultad de Ciencias Jurídicas y Sociales (School of Law and Social Sciences)	Law		http://www.ucu.edu.ar/Facultades-Carreras.htm
de Ciencias Empresariales y Sociales	Facultad de Ciencias Jurídicas y Sociales (School of Law and Social Sciences)	Law	Natural Resources and Environment.	http://www.uces.edu.ar/carreras1/abogaciaa.php
de Flores	Facultad de Ingeniería (School of Engineering)	Ecology Engineering	Introduction to Ecology; Environmental Geology; General Ecology; Environmental Analytical Chemistry; Environmental Communication; Applied Hydraulics; Natural Resources Management; Ecological Economics; Water and Liquid Waste; Environmental Impact Assessment; Environmental Laws; Environmental Ethics and Professional Code of Conduct; Environmental Management and Auditing.	http://www.uflo.edu.ar/academica/ingenieria/eco.htm
		Bachelor's Degree in Environmental Safety, Health and Control at the Workplace	Pollution Control; Ecology; Environmental Sanitation; Liquid Waste Treatment; Environmental Laws; Environmental Impact, Auditing and Management.	http://www.uflo.edu.ar/academica/ingenieria/seg_hig.htm
	Facultad de Derecho (School of Law)	Law	Natural Resources Applicable Laws; Environmental Law (Ecology and Law).	http://www.uflo.edu.ar/academica/derecho/der.htm

University	School/ Department	Programme	Courses (related to water and environmental issues)	Web Site
de Palermo	Facultad de Ingeniería (School of Engineering)	Industrial Engineering	Fluid Mechanics; Health, Laws and Industrial Ecology.	http://www.palermo.edu.ar/ingenieria/industrial/index.html
de San Andrés	Departamento de Economía (School of Economy)	Bachelor's Degree in Economics	Introduction to Ecology.	http://www.udesa.edu.ar//departamentos/economia/index
del Centro Educativo Latinoamericano	Facultad de Química (School of Chemistry)	Food Technology Engineering	Sanitation.	http://www.ucel.edu.ar/index.cgi?wid_seccion=1&wid_item=32
Maimónides	Facultad de Ciencias Médicas (School of Medical Sciences)	Biological Sciences	Ecology and Environmental Analysis; Applied Ecology for Habitat and Ecosystem Management; Physical Environment Dynamics.	http://www.maimonides.edu/infocarrera.asp?carrera=32&conte=3
	Facultad de Humanidades, Ciencias Sociales y Empresariales (School of Humanities, Social and Business Sciences)	Law	Natural Resources and Energy Law.	http://www.maimonides.edu/infocarrera.asp?carrera=43&conte=1

14.1.2.2. Bolivia

- Public Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Autónoma Juan Misael Saracho	Facultad de Ciencias y Tecnología (School of Sciences and Technology)	Civil Engineering	Hydraulics and Lab I; Hydrology; Hydraulics II and Lab; Water Resources Engineering; Sanitary Engineering I; Hydraulic Works; Environmental Impact in Civil Works. *Optional*: Wastewater Treatment Plants; Hydraulic Works II; Hydroelectric Power Plants; Irrigation and Drainage Engineering; Applied Hydrology; Hydraulics Lab.	http://www.uajms.edu.bo/facultades/Ciencias/Civil/
	Facultad de Ciencias Agrarias y Forestales (School of Agrarian and Forest Sciences)	Agronomic Engineering	Environment and Environmental Impact Assessment (optional); Irrigation. *Optional in the Soil and Irrigation Area:* Agricultural Soil Drainage; Agricultural Hydrology.	http://www.uajms.edu.bo/facultades/agricolas/agronomica/
		Forest Engineering	Forest Hydrology; Environmental Impact Assessment; Watershed Management; Forest Hydrologic Restoration.	http://www.uajms.edu.bo/facultades/agricolas/forestal/
		Higher-Education Technician in Agronomy (Yacuiba)	Irrigation.	http://www.uajms.edu.bo/facultades/agricolas/agroyac/#3

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Facultad de Ciencias Económicas y Financieras (School of Economical and Financial Sciences)	Economics	Environmental Economics (optional).	http://www.uajms.edu.bo/facultades/economicas/economia/
Autónoma Juan Misael Saracho	Facultad de Ciencias Jurídicas y Políticas (School of Law and Political Sciences)	Law	Environmental Law.	http://www.uajms.edu.bo/facultades/juridicas/
	Instituto Superior Agropecuario de Bermejo (High Agricultural Institute of Bermejo)	Higher-Education Agricultural Technician	Irrigation; Agroecology and Environment	http://www.uajms.edu.bo/facultades/agricolas/agropecuaria/
Autónoma Gabriel René Moreno	Facultad de Ciencias Exactas y Tecnología (School of Exact Sciences and Technology)	Civil Engineering	Hydraulics I; Hydraulics II; Hydrology; Sanitary Engineering I; Sanitary Engineering II; Hydraulic Works I; Environmental Sanitation; Ports and Waterways; Applied Hydrology; Drinking Water Treatment Plants; Wastewater Treatment Plants; Hydraulic Works.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=05&op=1

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
		Environmental Engineering	Hydrology; Natural Resources; Environmental Impact; Environmental Engineering; Water Pollution; Environmental Management; Natural Resources Assessment; Environmental Sanitation; Wastewater Management; Wastewater Treatment; Environmental Impact Assessment; Industrial Liquid Waste Treatment; Environmental Economics; Physical/Chemical and Microbiologic Analysis of Water; Environmental Pollution; Environmental Laws; Environmental Microeconomics. Topic Focus: Water.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=05&op=1
		Food Engineering	Liquid Waste Treatment in Food Industries; Optional: Environmental Management.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=05&op=1
Autónoma Gabriel René Moreno	Facultad de Ciencias Exactas y Tecnología (School of Exact Sciences and Technology)	Process Control Engineering	Water Treatment Processes; Environmental Impact and Management.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=05&op=1
	Facultad Politécnica (Polytechnic School)	Civil Works	Hydraulics; Water Sanitation.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=02&op=1
	Facultad de Ciencias Agrícolas (School of Agricultural Sciences)	Agronomic Engineering	Irrigation and Drainage; Agricultural Hydraulics; Design of Irrigation and Drainage Systems; Environmental Management.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=03&op=1
		Agricultural Engineering	Hydrology and Hydraulics; Irrigation and Drainage; Basic Rural Sanitation; Hydraulic Works.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=03&op=1
		Forest Engineering	Hydrology and Watershed Management.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=03&op=1

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
		Biology	Limnology; Environmental Conservation; Environmental Impact; Aquaculture; Applied Limnology. Environmental Economics.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=03&op=1
	Facultad de Veterinaria y Zootecnia (School of Veterinary and Animal Breeding)	Veterinary and Animal Breeding	Fish Breeding.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=07&op=1
		Agriculture and Farming (Yapacani)	Aquaculture and Fish Breeding.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=07&op=1
		Animal Breeding	Fish Breeding.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=07&op=1
Autónoma Gabriel René Moreno	Facultad de Humanidades (School of Humanities)	Sociology	Social and Environmental Impact Assessment of Projects; Industrial Social Processes and Environment.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=08&op=1
	Facultad de Ciencias Económicas y Financieras (School of Economic and Financial Sciences)	Economics	Environmental Economics and Resources.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=04&op=1
	Facultad Integral del Chaco (Integral School of Chaco)	Agricultural Engineering	Soil, Fertility and Irrigation; Natural Resources Management and Environmental Impact Assessment; Hydraulics, Irrigation and Drainage.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=01&op=1

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Facultad Tecnológica de Vallegrande (Technological School of Vallegrande)	Agricultural	Irrigation and Drainage.	http://www.uagrm.edu.bo/index_princ.php?opcion=4002&fac=00&op=1
Mayor, Real y Pontificia San Francisco Xavier de Chuquisaca	Facultad de Tecnología (School of Technology)	Civil Engineering	Hydraulics I; Hydraulics II; Sanitation I; Sanitation II; Hydrology; Hydraulics Lab; Sanitation III; Applied Hydraulics; River Hydraulics; Sanitation IV; Natural Resources and Environment; Agricultural Hydraulics	http://central.usfx.edu.bo/tecnologia/index.php?id=25&pm=no&in=es
Mayor, Real y Pontificia San Francisco Xavier de Chuquisaca	Facultad de Tecnología (School of Technology)	Environment	Applied Hydraulics; Renewable and Non-Renewable Energy Sources; Environmental Impact Assessment; Environmental Laws; Environmental Impact Assessment; Water Treatment I; Environmental Modelling; Water Treatment II; Environmental Auditing.	http://central.usfx.edu.bo/tecnologia/index.php?id=29&pm=no&in=es
		Chemical Engineering	Natural Resources.	http://central.usfx.edu.bo/tecnologia/index.php?id=20&pm=no&in=es
	Facultad Técnica (Technical School)	Topography	Hydraulics and Hydrology; Hydrology.	http://central.usfx.edu.bo/tecnica/index.php?id=42
		Civil Works	Hydraulic and Sanitation Works.	http://central.usfx.edu.bo/tecnica/index.php?id=41
	Facultad de Ciencias Económicas y Administrativas (School of Economic and Administrative Sciences)	Economics		http://central.usfx.edu.bo/economicas/index.php?id=38

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Facultad de Derecho, Ciencias Políticas y Sociales (School of Law, Political and Social Sciences)	Law		http://central.usfx.edu.bo/sociales/index.php?id=38&pag=79
Autónoma Tomás Frías	Facultad de Ingeniería (School of Engineering)	Civil Engineering		http://www.uatf.edu.bo/carreras/civ/civ.htm
		Civil Works		http://www.uatf.edu.bo/carreras/ccv/ccv.htm
Autónoma Tomás Frías	Facultad de Geología (School of Geology)	Geology Engineering		http://www.uatf.edu.bo/carreras/igo/Web_Geologia/pagina_geologia/objetivos_carrera.htm
		Environmental Engineering	Hydraulics; Hydrogeology; Environmental Laws and Ethics; Wastewater Engineering; Environmental Impact Assessment; Water Treatment; Environmental Modelling; Environmental Project Drafting and Assessment; Environmental Auditing.	http://www.uatf.edu.bo/carreras/igo/Web_Geologia/pagina%20medio_amb/objetivos_med_amb.htm
		Chemistry		http://www.uatf.edu.bo/carreras/qmc/qmc.htm
	Facultad de Ciencias Agrícolas y Pecuarias (School of Agricultural and Livestock Sciences)	Agronomic Engineering		http://www.uatf.edu.bo/carreras/agr/agr.htm
	Facultad de Derecho (School of Law)	Law		http://www.uatf.edu.bo/carreras/der/der.htm

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Facultad de Ciencias Económicas, Financieras y Administrativas (School of Economic, Financial and Administrative Sciences)	Economics		http://www.uatf.edu.bo/carreras/eco/eco.htm
Técnica de Oruro	Facultad de Ingeniería (School of Engineering)	Civil Engineering		http://www.uto.edu.bo/
Técnica de Oruro		Geology Engineering	Web site under construction.	http://www.uto.edu.bo/
		Chemical Processes Engineering	Web site under construction.	http://www.uto.edu.bo/
	Facultad Técnica (Technical School)	Civil Works		http://www.uto.edu.bo/
	Facultad de Ciencias Económicas y Financieras (School of Economic and Financial Sciences)	Economics		http://www.uto.edu.bo/

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Facultad de Ciencias Jurídicas, Políticas y Sociales (School of Law, Political and Social Sciences)	Law		http://www.uto.edu.bo/
Nacional Siglo XX	---	Mines - Topography		http://www.unsxx.edu.bo/informacion.html
	---	Agronomy		http://www.unsxx.edu.bo/informacion.html
	---	Law		http://www.unsxx.edu.bo/informacion.html

- Private Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Aquino de Bolivia	---	Environmental Engineering		http://www.udabol.edu.bo/carrerassc.htm
	---	Law		http://www.udabol.edu.bo/derecho.htm
	---	Agronomy		http://www.udabol.edu.bo/carrerassc.htm
Católica Boliviana San Pablo (Regional Santa Cruz de la Sierra)	Facultad de Ciencias Exactas e Ingeniería (School of Exact Sciences	Civil Engineering	Hydrology I; Hydrology II and Lab; Hydrology II; Drinking Water; Hydraulic Construction Works I; Sanitation Basics; Hydraulic Construction Works II; River Hydraulics.	http://www.ucbscz.edu.bo/Carreras/Programa_Dependiente.asp?C=CIV

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	and Engineering)	Higher-Education Technician in Agriculture and Farming		http://www.ucbscz.edu.bo/carreras/niveldeformacion.asp#Tec
		Higher-Education Technician in Bioecology		http://www.ucbscz.edu.bo/carreras/niveldeformacion.asp#Tec
Católica Boliviana San Pablo (Regional Tarija)	Facultad de Ingeniería (School of Engineering)	Civil Engineering		http://www.ucbtja.edu.bo/Carreras/IngenieriaCivil/index.aspx
		Law		http://www.ucbtja.edu.bo/Carreras/Derecho/index.aspx
Nur Bolivia	----	Farm Economics		http://www.nur.edu/52626/docs/spa/wd_m52c20110104_a.pdf
Privada Santa Cruz de la Sierra	Facultad de Ingeniería (School of Engineering)	Civil Engineering	Applied Hydrology; Applied Hydraulics I; Environmental Sanitary Engineering; Hydraulic and Sanitation Facilities; Applied Hydraulics II.	http://www.upsa.edu.bo/ing_civil.php
	Facultad de Ciencias Jurídicas (School of Law Sciences)	Law	Environmental Law.	http://www.upsa.edu.bo/derecho.php
Evangélica Boliviana	Facultad de Ciencias Agrícolas, Biológicas, Pecuarias y Veterinarias (School of Agricultural, Biological, Livestock and Veterinary	Agriculture and Farming	Irrigation and Drainage; Fish Breeding (optional).	http://www.ueb.edu.bo/agropecuaria.html

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Sciences)			
Privada del Valle (Univalle)	Facultad de Ingeniería y Arquitectura (School of Engineering and Architecture)	Civil Engineering	Hydraulics I; Hydraulics II; Hydrology; Sanitary Engineering I; Hydraulic Works I; Sanitary Engineering II; Hydraulic Works II.	http://www.univalle.edu/plan_estudios/ingenieria/civil/civil.htm
	Facultad de Ciencias Sociales y Administrativas (School of Social and Administrative Sciences)	Bachelor's Degree in Law and Legal Sciences	Environmental Law.	http://www.univalle.edu/plan_estudios/cs_sociales/derecho/derecho.htm
Nacional del Oriente	Facultad de Ciencia y Tecnología (School of Science and Technology)	Forestry	Watershed Management; Environmental Management.	http://www.uno.edu.bo/forpro/foresta
Nacional del Oriente	Facultad de Ciencias Sociales y Jurídicas (School of Social and Law Sciences)	Law	Environment (optional).	http://www.uno.edu.bo/forpro/derecho
Nacional Ecológica	----	Environmental Engineering	Introduction to Environmental Engineering; Environmental Sciences: Natural Resources I; Economics and Environment; Natural Resources II; Environmental Diagnosis and Management; Management and Planning; Environmental Laws;	http://www.uecologica.edu.bo/ingenieriama.htm

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
			Hydrology; Watershed Management; Conservation of Resources.	

14.1.2.3.Brazil

- Public Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Federal de Brasilia	Facultad de Agronomía y Medicina Veterinaria (School of Agronomy and Veterinarian Medicine)	Agronomic Engineering	Introduction to Agronomy and Environmental Sciences; Agricultural Hydraulics; Soil and Water Conservation; Irrigation Management and Methods.	http://www.unb.br/fav/graduac.htm
Federal de Brasilia	Facultad de Tecnología (School of Technology)	Civil and Environmental Engineering	Irrigation and Drainage Systems; Applied Hydrology; Environmental Sanitation; Hydraulic Sanitation Systems; Site Hydraulic Systems; Water Quality; Waterway Systems; Environmental Management; Theoretical Hydraulics; Experimental Hydraulics; Water Fundamentals.	http://www.unb.br/ft/enc

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Facultad de Ciencias Humanas (School of Human Sciences)	Geography		http://www.unb.br/ih/gea/
	Instituto de Geociencias (Institute of Geosciences)	Geology	Hydrogeology.	http://unb.br/ig/grad/cursogeologia.htm
Federal de Goias	Escuela de Ingeniería Civil (School of Civil Engineering)	Civil Engineering	Hydraulics; Hydrology; Environmental Sciences.	http://www.ufg,br/cursos/graduacao/engenhariacivil.php
	Escuela de Agronomía y de Ingeniería Ambiental (School of Agronomy and Environmental Engineering)	Agronomy	Fields include botany, biochemistry, plant physiology, soils, genetics, statistics and experiments, agricultural climatology, topography, hydraulics, sociology, etc.	http://www.ufg.br/graduacao/agronomia.php http://www.agro.ufg.br/
Federal de Goias	Instituto de Estudios Socio ambientales (Institute of Socio Environmental Studies)	Geography	Environmental Planning	http://www.iesa.ufg.br/ http://www.ufg.br/cursos/graduacao/geografia.php
Federal de Santa Maria	Centro de Ciencias Ruralees (Centre of Rural Sciences)	Agronomy	Agricultural Hydraulics A; Irrigation and Drainage; Farm and Environmental Laws.	http://www.ufsm.br/ccr

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Centro de Tecnología (Centre of Technology)	Civil Engineering	Hydraulics A; Hydrology A; Hydraulics B; Water Supply and Treatment; Complementary Issues of Hydrology; Environmental Engineering A; Water Resources Geoprocessing.	http://www.portal.ufsm.br/ementario/cursos
Federal de Mato Grosso	Facultad de Agronomía y Medicina Veterinaria (School of Agronomy and Veterinarian Medicine)	Agronomy	Agricultural Meteorology and Climatology; General Ecology; Agricultural Hydraulics; Irrigation and Drainage; Renewable Natural Resources (optional: Fish Breeding).	http://www.ufmt.br
		Veterinary Doctor	General Ecology.	http://www.ufmt.br
	Facultad de Ingeniería Forestal (School of Forest Engineering)	Forest Engineering	Agricultural Meteorology and Climatology; General Ecology; Hydraulics; Forest Ecology; Watershed Management; (Optional: Fish Breeding).	http://www.ufmt.br
	Facultad de Arquitectura, Ingeniería y Tecnología (School of Architecture, Engineering and Technology)	Civil Engineering	Environmental Sciences; Applied Hydrology; General Hydraulics; Hydraulic and Sanitation Facilities; Drainage Systems; Bridges.	http://www.ufmt.br
Federal de Mato Grosso		Civil and Environmental Engineering	Introduction to Sanitary and Environmental Engineering; Quality of Supply Water; Biological Reasons for Sanitation; Geology for Sanitary and Environmental Engineering; Wastewater Quality; Applied Hydrology; General Hydraulics; Environmental Sciences; Treatment of Supply Water; Wastewater Treatment; Water Supply System; Environmental Laws; Site Hydraulic and Sanitation Facilities; Water Resources; Environmental Impact Assessment; Industrial Wastewater Treatment; Education and Environment; Ports and Waterways	http://www.ufmt.br

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Instituto de Biociencias (Institute of Biosciences)	Bachelor's Degree in Biological Sciences	Ecology of Systems; Ecology of Communities; Ecology of Population Centers; Natural Resources Conservation and Preservation; Environmental Microbiology; Fish Breeding; Pollution Ecology; Urban Ecology; Ecology of Floodable Areas	http://www.ufmt.br
	Instituto de Ciencias Humanas y Sociales (Institute of Human and Social Sciences)	Geography	Climatology I and II; Biogeography; Hydrography; Environmental Planning; (Optional: Bioclimatology and General Ecology).	http://www.ufmt.br
	Ingeniería Forestal (Forest Engineering)	Forest Engineering	Agricultural Meteorology and Climatology; General Ecology; Hydraulics; Forest Ecology; Watershed Management; (Optional: Fish Breeding).	http://www.ufmt.br
Federal de Mato Grosso do Sul	Facultad de Ciencias Biológicas y de la Salud (School of Biological and Health Sciences)	Biology	Climatology; Sampling Methods in Biological and Environmental Studies	http://www.ufms.br
		Veterinary Sciences	Ecology; Fish Breeding.	http://www.ufms.br

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Federal de Mato Grosso do Sul	Facultad de Ciencias Exactas y Tecnología (School of Exact Sciences and Technology)	Environmental Engineering	Biology Applied to Environmental Engineering; Information Technology Applied to Environmental Engineering; Introduction to Environmental Engineering; Chemistry Applied to Environmental Engineering; Ecology Applied to Environmental Engineering; General Hydraulics; Applied Hydraulics; Meteorology and Climatology; Numerical Methods Applied to Environmental Engineering Water Quality; Groundwater; Environmental Ethics, Law and Regulations; Principles of Water and Sewage Treatment, Environmental Management System; Water Distribution and Sewage Collection Systems; Environmental Impact Assessments; Optimisation of Environmental Systems; Environmental Project Planning and Development; Water and Sewage Treatment Systems Project; Water Resources	http://www.ufms.br
		Civil Engineering		http://www.ufms.br
Universidad Federal do Paraná	Sector de Ciencias Agrarias (Deparment of Agrarian Sciences)	Agronomic Engineering	Irrigation and Drainage; Hydraulics and Hydrology.	http://www.agrarias.ufpr.br
		Forest Engineering	Hydrology and Watershed Management.	http://www.floresta.ufpr.br
	Sector de Ciencias de la Tierra (Department of Earth Sciences)	Geography	Hydrogeography; Geography and Environmental Analysis; Watershed Management.	http://www.terra.ufpr.br http://www.geog.ufpr.br
		Geology	Hydrogeology; Applied Hydrogeology; Energy Resources II; Environmental Geology; Analysis of Basins; Geoenvironmental Risks.	http://www.geologia.ufpr.br

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Sector de Tecnología (Department of Technology)	Environmental Engineering	Introduction to Environmental Engineering; Environmental Hydrology; Environmental Sanitation I; Environmental Sanitation II; Geographic Information Systems Applied to the Environment.	http://www.ufpr.br/
Universidad Federal do Paraná	Sector de Tecnología (Department of Technology)	Civil Engineering	Water Resources Engineering.	http://www.ufpr.br/
		Chemical Engineering	Liquid Waste Treatment.	http://www.ufpr.br/
	Sector de Ciencias Exactas (Deparment of Exact Sciences)	Chemistry	*Optional:* Ecology; Environmental Chemistry; Environmental Sciences I.	http://quimica.ufpr.br/cquim/cquim.html
	Sector de Ciencias Jurídicas (Department of Law Sciences)	Law	Environmental Law.	http://www.direito.ufpr.br/
Universidad Federal de São Carlos	Centro de Ciencias Agrarias (Centre of Agrarian Sciences)	Agronomic Engineering	Environmental Sciences; Agricultural Hydraulics; Water Relations in the Soil-Plant-Atmosphere System; Irrigation and Drainage; Pollution and Environmental Impacts; Environmental Hydrology; Physical Environmental Analysis; Ecologic Economics and Environmental Assessment.	http://www.cca.ufscar.br

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Centro de Ciencias Exactas y Tecnología (Centre of Exact Sciences and Technology)	Civil Engineering	Applied Hydrology; Hydraulics 2; Sanitation Systems; Site Hydraulic and Sanitation Systems 1; Environmental Comfort; Site Hydraulic and Sanitation Systems 2. *Specialised in Urban Engineering:* Urban Drainage; Sanitation Liquid Waste Treatment; Urban Environmental Management. *Optional:* Water Treatment and Supply; Leakage Control in Water Supply Systems; Ports and Waterways; Groundwater and Wells; Water Resources Planning and Supply; Street Drainage.	http://www2.ufscar.br/interface_frames/index.php?link=http://www.deciv.ufscar.br
Universidad Federal de São Carlos	Centro de Ciencias Biológicas y de la Salud (Centre of Biological and Health Sciences)			
Universidad Federal de Uberlândia	Instituto de Geografía (Institute of Geography)	Geography	Environmental Planning I; Environmental Planning II; Environmental Sciences; Hydrogeography; Natural Resources.	http://www.prograd.ufu.br
	Instituto de Ciencias Agrarias (Institute of Agrarian Sciences)	Agronomy	Agricultural Hydraulics; Soil and Water Management and Conservation; Irrigation and Drainage.	http://www.prograd.ufu.br
	Facultad de Ingeniería Civil (School of Civil Engineering)	Civil Engineering	General Hydraulics; Applied Hydrology; Water Supply; Environmental Sciences; Sanitation; Water Treatment; Ports and Waterways.	http://www.prograd.ufu.br
Federal de São	Escuela de	Environmental	Culture, Environment and Development;	http://www.eesc.usp.br/

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Paulo	Ingeniería de São Carlos (School of Engineering of São Carlos)	Engineering	Environmental Description: Watershed; Climatology and Physical Hydrology; Environmental Impact and Adaptation; Environmental Impact Assessment; Water Resources; Hydraulics; Environmental Impact Mitigation Actions; Applied Environmental Economics; Water Treatment; Energy Resources and Development; Environmental Planning and City Planning; Environmental Management; Mathematic Modelling of Environmental Systems; Environmental Licensing; Environmental Policy Instruments; Energy Conservation; Environmental Effects of Energy Usage; Environmental Impact Case Studies; Environmental Monitoring; Environmental Adaptation in Urban Areas; Energy, Society and Environment; Environmental Laws; Water Supply Treatment Systems; Advanced Water Treatment.	
Federal de São Paulo	Escuela de Ingeniería de São Carlos (School of Engineering of São Carlos)	Civil Engineering	Hydraulics; Hydrology and Water Resources; Hydraulic and Sanitation Facilities; Water Quality; Supply Water Treatment; Hydraulic Works Topics; Hydrologic and Water Quality Models; Groundwater Hydraulics; Hydraulics of Water Treatment Stations; Hydraulics and Sanitation; Mathematical Modelling; Irrigation and Drainage.	http://www.eesc.usp.br/
		Electrical Engineering (focused on Energy and Automation)	Hydroelectrical Developments.	http://www.eesc.usp.br/

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Instituto de Geociencias (Institute of Geosciences)	Geology	Hydrology and Water Resources; Environmental Geology; City Planning, Industrialisation and Environment; Hydrogeochemistry; Thermomineral Water Resources.	http://www.igc.usp.br/ensino/graduacao
		Geosciences and Environmental Education	Environmental Geology I and II; Environmental Education; Environmental Geochemistry; Energy Resources; City Planning, Industrialisation and Environment.	http://www.igc.usp.br/ensino/graduacao
	Facultad de Filosofia, Letras y Ciencias Humanas (School of Phylosophy, Arts and Human Sciences)	Geography	Natural Resources Geography; Environmental Cartography; Hydrography.	http://www.geografia.fflch.usp.br
Estadual de Campinas	Centro Superior de Educación Tecnológica (High Centre of Technological Education)	Higher-Education Technician in Sanitation Technology	*Oriented to Basic Sanitation:* Hydrotechnique I; Environmental Pollution and Sanitation; Hydrology and Drainage; Environmental Education and Awareness; Environmental Regulations and Policy; Tubing and Construction of Water Supply Networks; Water Treatment; Hydraulic Works; Site Hydraulic and Sanitation Facilities; Water and Sewerage Distribution System; Irrigation.	http://www.unicamp.br/prg/dac/catalogo2001/

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
		Higher-Education Technician in Sanitation Technology	*Oriented to Environmental Control:* Hydrotechnique I; Environmental Pollution and Sanitation; Hydrology and Drainage; Environmental Education and Awareness; Environmental Regulations and Policy; Environmental Geology; Environmental Toxicology; Environmental Pollution Chemistry; Environmental Monitoring; Environmental Planning; Computer Models for Environmental Systems; Environmental Management; Environmental Impact Assessment; Environmental Quality and Specific Standards; Special Topics of Environmental Control; Energy Resources and Environment; Environment and Development.	http://www.ige.unicamp.br/ http://www.unicamp.br/prg/dac/catalogo2001/
	Instituto de Geociencias (Institute of Geosciences)	Geography	Hydrology and Oceanography; Urban Environment; Watershed Analysis and Management.	http://www.ige.unicamp.br/ http://www.unicamp.br/prg/dac/catalogo2005/
		Geology	Natural Resources Law; Hydrogeology; Energy Resources Geology; Environmental Law.	http://www.ige.unicamp.br/ http://www.unicamp.br/prg/dac/catalogo2005/
Estadual de Campinas	Facultad de Ingeniería Civil, Arquitectura y Urbanismo (School of Civil Engineering, Architecture and Urbanism)	Civil Engineering	Water Health Quality; Site Hydraulic and Sanitation Facilities; Applied Hydrology; Supply Water Treatment.	http://www.ige.unicamp.br/ http://www.unicamp.br/prg/dac/catalogo2005/
Estadual de Campinas	Facultad de Ingeniería Agrícola (School of Agricultural Engineering)	Agricultural Engineering	General Hydraulics; Water Resources; Environmental Sanitation; Irrigation Techniques; Irrigation Engineering; Hydraulic Facilities in Rural Areas; Water Resources Management; Soil-Water-Atmosphere Systems Applied to Agriculture ;	http://www.unicamp.br/ http://agr.unicamp.br/

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
			Hydroenergetic Development in Rural Areas; Hydraulics Basics Applied to Agricultural Machinery .	
Estadual de Mato Grosso do Sul	---	Agronomy	Environmental Management; Hydraulics, Irrigation and Drainage; Soil and Water Management and Conservation.	http://www.uems.br/internet/agronomia/
Estadual de Londrina	Centro de Ciencias Agrarias (Centre of Agrarian Sciences)	Agronomy	Ecology and Preservation of Natural Resources; Hydraulics, Irrigation and Drainage; Renewable Energy Sources.	http://www.uel.br/cca/agro
	Centro de Ciencias Exactas (Centre of Exact Sciences)	Geography	-Continental and Ocean Hydrology; Natural Resources and Environmental Analysis.	http://www.geo.uel.br
	Centro de Tecnología y Urbanismo (Centre of Technology and Urbanism)	Civil Engineering	Environmental Management in Civil Engineering; Hydraulics I and II; Applied Hydrology and Drainage Systems; Hydraulic and Site Facilities I and II.	http://www.uel.br/ctu
Estadual de Maringá	Centro de Ciencias Agrarias (Centre of Agrarian Sciences	Agronomy	Soil and Water Classification, Management and Conservation; Irrigation and Drainage.	http://www.dag.uem.br
	Centro de Ciencias Humanas, Letras y Artes (Centre of Human Sciences and Arts)	Geography	Hydrogeography; Environmental Planning.	http://www.uem.br/dge

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Centro de Tecnología (Centre of Technology)	Civil Engineering	Hydrology; Hydraulics; Water Supply and Sewerage Systems.	http://www.dec.uem.br
Estadual de Ponta Grossa	Sector de Ciencias Agrarias y Tecnología (Department of Agrarian Sciences and Technology)	Civil Engineering	Applied Hydrology; Hydraulics; Sanitation and Hydraulic Facilities.	http://www.uepg.br/denge/index.htm
		Agronomy	Irrigation and Drainage; Hydraulics; Agricultural Drainage.	http://www.uepg.br/uepg_departamentos
	Sector de Ciencias Exactas (Deparment of Exact Sciences)	Geography	Hydrology and Water Resources; Land and Environmental Planning; Environmental and City Planning Laws.	http://www.uepg.br/uepg_departamentos/degeo/
Estadual del Oeste del Paraná	Centro de Ciencias Exactas y Tecnológicas (Centre of Exact and Technological Sciences)	Agricultural Engineering	Environmental Science for Agricultural Engineering; Fluid Mechanics and Hydraulics; Irrigation; Hydrology; Watershed Management and Environmental Drainage; Environmental Management.	http://www.unioeste.br/prg/
		Civil Engineering	Environmental Sciences for Civil Engineering; Fluid Mechanics and Hydraulics; Hydrology; Sanitary and Environmental Engineering I and II.	http://www.unioeste.br/prg/
Estadual del Oeste del Paraná	Centro de Ciencias Humanas (Centre of Human Sciences)	Geography	Geography of Continental and Ocean Water; Environmental Planning.	http://www.unioeste.br/prg/
	Centro de Ciencias Agrarias (Centre of Agrarian Sciences)	Agronomy	Hydraulics and Hydrology; Irrigation and Drainage; Environmental Management and Administration.	http://www.unioeste.br/prg/

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	Centro de Ciencias Humanas, Educación y Letras (Centre of Human Sciences, Education and Arts)	Geography	Climatology and Hydrogeography.	http://www.unioeste.br/prg/

- Private Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Pontificia Universidad Católica de Campinas	Centro de Ciencias Exactas, Ambientales y de Tecnología (Centre of Exact and Environmental Sciences and Technology)	Environmental Engineering		http://www.puc-campinas.edu.br/graduacao/
		Civil Engineering		http://www.puc-campinas.edu.br/graduacao/
		Geography (focused on Land and Environmental Management)		http://www.puc-campinas.edu.br/graduacao/
Pontificia Universidad Católica de Sao Paulo	Facultad de Ciencias Sociales (School of Social Sciences)	Geography	Hydrogeography I; Hydrogeography II.	http://www.pucsp.br/facsoc
Mackenzie	Escuela de Ingeniería (School	Civil Engineering	Applied Hydraulics I; Hydraulics I; Applied Hydraulics II; Hydraulics II; Applied Hydrology; Site	http://www.mackenzie.com.br/universidade/engenharia/

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
	of Engineering)		Hydraulic Facilities; Hydraulic Works.	
Bandeirante de Sao Paulo	---	Civil Engineering		http://www.uniban.br/frame.html
Paulista	---	Civil Engineering		http://www2.unip.br/ensino/graduacao/tradicionais
Santa Cecilia	Facultad de Ingeniería (School of Engineering)	Civil Engineering	Hydrology and Drainage Works; General Hydraulics; Hydraulic and Sanitation Facilities.	http://www.unisanta.br/faculdades/index.asp
de Taubate	Instituto de Biociencias (Institute of Biosciences)	Agronomy	Hydrology and Watershed Management; Hydraulics, Irrigation and Drainage.	http://www.unitau.br/universidade/departamentos/
	Instituto de Exactas (Institute of Exacts)	Civil Engineering	Environmental Sciences; Hydraulics; Applied Hydrology.	http://www.unitau.br/universidade/departamentos/
		Environmental and Sanitary Engineering	Inorganic and Water Chemistry; Culture, Environment and Development; Environmental Microbiology; Environmental Law and Sociology; Energy, Environment and Atmosphere Physics; Transportation and Environment; Environmental Geotechnique; Hydraulics; Hydrology and Watersheds; Environmental Planning and Management; Environmental Policies; Water Treatment and Distribution Systems; Related Environmental Impacts; Irrigation and Drainage Systems.	http://www.unitau.br/universidade/departamentos/
	Instituto de Ciencias Humanas (Institute of Human Sciences)	Geography	Environmental Theory and Laws; Environmental Impact Studies.	http://www.unitau.br/universidade/departamentos/

14.1.2.4. Paraguay

- Public Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Nacional de Asunción	Facultad de Ingeniería (School of Engineering)	Civil Engineering	Hydraulics; Hydrology; Sanitary and Environmental Engineering.	http://sdi.cnc.una.py/cpa/catalogo.cgi?rm=carrInf&origen=UNA&modo=DEF&codfacul=ING%20%20&codcarre=CIVIL&planvigente=CIV-PLS
		Geographical Sciences Engineering	General Hydrology and Hydraulics; Introduction to Environmental Science; Environmental Assessment and Management.	http://www.ing.una.py/documentos/guia2005/MALLA%20CURRICULAR%20CIENCIAS%20GEOGRAFICAS.pdf
Nacional de Asunción	Facultad de Ciencias Agrarias (School of Agrarians Sciences)	Agronomic Engineering	Agricultural Hydraulics.	http://sdi.cnc.una.py/cpa/catalogo.cgi?rm=carrInf&origen=UNA&modo=DEF&codfacul=AGR%20%20&codcarre=IA%20%20%20&planvigente=11-1
		Forest Engineering	Hydraulics and Hydrology.	http://sdi.cnc.una.py/cpa/catalogo.cgi?rm=carrInf&origen=UNA&modo=DEF&codfacul=AGR%20%20&codcarre=IF%20%20%20&planvigente=11-4
	Facultad de Ciencias Químicas (School of Chemical Sciences)	Chemical Engineering	Environmental Engineering.	http://sdi.cnc.una.py/cpa/catalogo.cgi?rm=carrInf&origen=UNA&modo=DEF&codfacul=QUI%20%20&codcarre=IQ%20%20%20&planvigente=P3-I
		Food Science and Technology		http://sdi.cnc.una.py/cpa/catalogo.cgi?rm=carrInf&origen=UNA&modo=DEF&codfacul=QUI%20%20&codcarre=QTA%20%20&planvigente=T
	Facultad de	Chemistry		The link is not working

	Ciencias Exactas y Naturales (School of Exact and Natural Sciences)	Biology		The link is not working
		Geology		The link is not working
	Facultad de Economía (School of Economy)	Economics (with a certificate in Microeconomics)	Environmental Economics.	http://www.eco.una.py/economia02.htm
Nacional del Pilar	Facultad de Ciencias Aplicadas (School of Applied Sciences)	Bachelor's Degree in Environmental Sciences		http://www.unp.edu.py/aplicadas/cienciasamb.htm
Nacional del Pilar	Facultad de Ciencias Agropecuarias y Desarrollo Rural (School of Agricultural and Livestock Sciences and Rural Development)	Agricultural Engineering	Hydraulics and Water Management.	http://www.unp.edu.py/agropecuarias/detingagrop.htm

- Private Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site

Católica Nuestra Señora de Asunción	Facultad de Ciencias y Tecnología (School of Sciences and Technology	Civil Engineering	Applied Hydraulics; Hydrology and Hydraulic Works.	http://www.uca.edu.py/
Columbia del Paraguay	---	Law	River and Maritime Law; Environmental Law.	http://www.columbia.edu.py/carreras/derecho.html#4
del Norte	Facultad de Ingeniería (School of Engineering)	Civil Engineering		http://www.uninorte.edu.py/contenido/ingenieria_civil.php
	Facultad de Derecho (School of Law)	Law	Environmental Law; Human Rights and the Environment.	http://www.uninorte.edu.py/contenido/derecho.php

14.1.2.5. Uruguay

- Public Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site

de la República	Facultad de Ingeniería (School of Engineering)	Civil Engineering (Hydraulic-Environmental Profile)	*Fluids Area:* Fluid Mechanics; Hydrology and Applied Hydraulics. *Construction Area:* Hydraulic Constructions *Environmental Sciences Area:* Environmental Impact Analysis; Environmental Engineering Fundamentals; Environmental Engineering I; Environmental Engineering II. *Sanitation Area:* Drinking Water I; Drinking Water II; Liquid and Industrial Waste I; Liquid and Industrial Waste II; Drinking Water and Sewerage Networks; Sanitary Conditioning.	http://www.fing.edu.uy/servadm/secretaria/comisiones/claustro/carreras.htm
		Chemical Engineering	Liquid Waste Treatment; Biochemical Engineering; Fluid Dynamics; Biological Processes Technology.	http://www.fing.edu.uy/servadm/secretaria/comisiones/claustro/carreras.htm
	Facultad de Agronomía (School of Agronomy)	Agronomic Engineer	Workshop 2 (related to natural resources and their socioeconomic and production importance); Rice; Irrigation Systems.	http://www.fagro.edu.uy/index_ensenia.html
	Facultad de Ciencias (School of Sciences)	Bachelor's Degree in Geography	Hydrology; Natural Resources and Environmental Impact Assessment.	http://www.fcien.edu.uy/menu1/planes1/geogra1.html
		Bachelor's degree in Geology	Hydrogeology (advanced study courses).	http://www.fcien.edu.uy/menu1/planes1/geo1.html
		Bachelor's Degree in Biological Sciences (oriented to Ecology)	Limnology Basics. There is a specialisation in Limnology.	http://www.fcien.edu.uy/menu1/planes1/biol1.html
		Technical Degree in Natural Resources Management		http://www.fcien.edu.uy/menu1/planes1/biol1.html

- Private Institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web Site
Universidad de Montevideo	Facultad de Ingeniería (School of Engineering)	Civil Engineering	Hydraulics; Hydrology; Environmental Engineering; Sanitary Engineering I; Sanitary Engineering II.	http://www.um.edu.uy/Carreras/De+Grado/ing-civil/default.aspx
Universidad de la Empresa	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Bachelor's Degree in Agricultural Management	Irrigation Systems I; Irrigation Systems II (optional courses for the specialisation programme).	http://www.fca-ude.edu.uy/Index2.htm

14.2. Research

14.2.1. Research Institutions

Information about research related to water and environmental issues was organised considering:

– Type of institution (public / private)
– Name of the institution
– Unit
– Location
– Ongoing projects (at the end of 2005)
– Other activities carried out by the institution
– Web site

This information is presented in tables, by institution.

14.2.1.1. Argentina

- Public Institutions

Name of Institution	**Laboratorio de Hidráulica, LH (Hydraulics Laboratory)**
Unit	Instituto Nacional del Agua, INA (National Water Institute)
Location	Ezeiza, Province of Buenos Aires, Argentina
Research Areas	Fluvial, maritime, structural, computational and industrial hydraulics and instrumentation and hydraulic impact of infrastructure works
Ongoing Projects	Simulation and prediction of the increase of the Paraná River Delta front; Water quality mathematical model of Yacyretá reservoir and its tributaries; Effect of climate change on the La Plata River floods; Diagnosis on the hydrological-hydraulic behaviour of the Luján river basin
Other Activities	Specialised library
Web Site	http://www.ina.gov.ar/

Name of Institution	**Centro de Tecnología del Uso del Agua, CTUA (Water Use Technology Centre)**
Unit	Instituto Nacional del Agua, INA (National Water Institute)
Location	Ezeiza, Province of Buenos Aires, Argentina

Research Areas	Water quality in receiving water bodies; Treatment of water and wastewater; Final disposal of wastewater; Final disposal of wastes and environmental sanitation
Ongoing Projects	Study for pollution prevention in the Matanza-Riachuelo river basin; Studies of biodegradability and toxicity of inhibiting compounds of biological activity and persistent in water bodies; Monitoring of surface water and sediments quality in the Luján river basin
Other Activities	Specialised library of the Centro Argentino de Ingeniería Sanitaria y Ciencias del Ambiente, CARIS (Argentinean Centre of Sanitary Engineering and Environmental Sciences)
Web Site	http://www.ina.gov.ar/

Name of Institution	**Dirección de Servicios Hidrológicos, DSH (Hydrological Services Directorate)**
Unit	Instituto Nacional del Agua, INA (National Water Institute)
Location	Ezeiza, Province of Buenos Aires, Argentina
Research Areas	Studies and technological projects for the assessment of water resources atmospheric, surface and underground components
Ongoing Projects	Study of sources for water supply in several municipalities of the Province of Corrientes; Modelling of the process precipitation-discharge and areal estimation of evapotranspiration in the Ibicui and Chopim rivers basins; Analysis of the hydrological response of a basin under different hypothesis of climate change
Web Site	http://www.ina.gov.ar/

Name of Institution	**Dirección de Sistemas de Información y Alerta Hidrológico, SiyAH (Information Systems and Hydrological Warning Directorate)**
Unit	Instituto Nacional del Agua, INA (National Water Institute)
Location	Ezeiza, Province of Buenos Aires, Argentina
Research Areas	Development and operation of a hydrological forecasting and warning service for the La Plata River Basin; Coordination of water resources numerical and documentary information
Ongoing Projects	Operation of the La Plata Basin Hydrological Warning System since 1982/83, without any interruption
Other Activities	Specialised library
Web Site	http://www.ina.gov.ar/
Name of Institution	**Centro Regional Litoral, CRL (Litoral Regional Centre)**

Unit	Instituto Nacional del Agua, INA (National Water Institute)
Location	Santa Fe, Province of Santa Fe, Argentina
Research Areas	Studies, research and specialised services in the field of hydraulics and hydrology, looking for solutions to the problems related to the development of water systems in its area of influence, the provinces of Santa Fe, Chaco, Formosa, Misiones, Corrientes and Entre Ríos
Ongoing Projects	Delimitation of water risks areas in the province of Santa Fe; Discharge of the La Picasa Lake into the Paraná River; Availability of surface water for reservoirs devoted to irrigation in the province of Entre Ríos; Control of morphologic evolution in Santa Fe harbour
Other Activities	Specialised library; Development of urban stormwater drainage sinks; Drilling of wells for evaluation of groundwater availability
Web Site	http://www.ina.gov.ar/
Name of Institution	**Grupo de Análisis y Modelación de Procesos Hidrológicos (Hydrologic Processes Analysis and Modelling Group)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad de Buenos Aires, UBA (University of Buenos Aires)
Location	City of Buenos Aires, Argentina
Ongoing Projects	Analysis of the Time Evolution of Hydrologic Variables in Flooded Areas and Soil Reuse (UBA)
Other Activities	Development and application to various Argentine basins of mathematical models to represent hydrologic processes of rainfall-volume flow transformation on a deterministic/probabilistic basis.
Web Site	http://www.fi.uba.ar/autoridades/secretarias/invydoc/laboratorios/index.php

Name of Institution	**Grupo de Hidráulica Fluvial (Fluvial Hydraulics Group)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Services to Third Parties	Different types of assistance
Ongoing Projects	Transporte de Sedimentos en Cauces Aluviales (Sediment Transportation in Alluvial Channels, UBA)
Other Activities	Physical Model Testing; Mathematical Models of High Flow Movement; Research of Particle Concealment at Movement Inception

Web Site	http://www.fi.uba.ar/autoridades/secretarias/invydoc/laboratorios/index.php

Name of Institution	**Laboratorio de Modelación Matemática (Mathematical Modelling Lab)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Ongoing Projects	Numerical Simulation of River Beds Morphologic Evolution with Bank Erosion (UBA); Uncertainty and Risk in Agricultural Planning Decision-Making with respect to Weather Forecasts (NOAA, USA); Understanding and Modelling the Scope for Adaptive Management in Agroecosystems in the Pampas in Response to Interannual and Decadal Climate Variability and Other Risk Factors (National Scientific Foundation)
Other Activities	Work Network with the INA (National Water Institute) Computer Hydraulics Programme.
Web Site	http://www.fi.uba.ar/autoridades/secretarias/invydoc/laboratorios/index.php

Name of Institution	**Instituto de Investigaciones Fisiológicas y Ecológicas vinculadas a la Agricultura – IFEVA (Agriculture-Related Physiological and Ecological Research Institute)**
Unit	Facultad de Agronomía, Universidad de Buenos Aires (UBA) and Consejo Nacional de Ciencia y Técnica (CONICET, National Science and Technical Council)
Location	City of Buenos Aires, Argentina
Research Areas	Global Change; Ecology of Pastureland; Ecology of Agricultural and Forest Systems
Ongoing Projects	Effects of deep ripping on the physical properties of the soil and the movement of surface water in direct crop systems; Surface water quality and pollution as a resource for animal drinking purposes in a representative basin of the undulated Pampas; Contaminant dynamics and remediation guidelines for the Matanza River-Riachuelo basin; Effects of agrometeorological variables on regional agricultural calendars for corn and wheat in the Pampas Region; Regulatory and economic instruments for water resources management in a rice subbasin of the Miriñay River, in the Province of Corrientes; Environmental vulnerability of microbasins with different geomorphic energies belonging to the “Arroyo del Tala” stream, San Pedro, Province of Buenos Aires.
Other Activities	Teaching of undergraduate and graduate programme courses
Web Site	http://www.ifeva.edu.ar/

Name of Institution	**Unidad de Investigación Planeamiento Urbano y Regional (Urban and Regional Planning and Research Unit)**

Unit	Facultad de Arquitectura, Diseño y Urbanismo, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Ongoing Projects	Patterns and Processes in Urban-Rural Relations. The case of the Undulated Pampas and the coastal lands; Habitat and Sustainable Development: A New Local Management Approach.
Web Site	http://www.fadu.uba.ar/investigacion/produccion/

Name of Institution	**Unidad de Investigación Proyecto y Habitar ("Proyecto y Habitar" Research Unit)**
Unit	Facultad de Arquitectura, Diseño y Urbanismo, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Ongoing Projects	Health and Environmental Indicators for Sustainable Childhood Growth; Low-Income Habitat in Flood-Risk Areas in Santa Fe.
Other Activities	Teaching
Web Site	http://www.fadu.uba.ar/investigacion/produccion/unidades/proyecto/sitio/index.html

Name of Institution	**Grupo de Ecología del Paisaje y Medio Ambiente – GEPAMA (Landscape Ecology and Environment Group)**
Unit	Facultad de Arquitectura, Diseño y Urbanismo, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Web Site	http://www.fadu.uba.ar/investigacion/produccion/sedes/cen.html

Name of Institution	**Instituto Superior de Urbanismo – ISU (Higher Education City Planning Institute)**
Unit	Facultad de Arquitectura, Diseño y Urbanismo, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Research Areas	Various topics related to city management.
Services to Third Parties	Technical assistance, consulting and advisory services; Jobs for the Government of the City of Buenos Aires (GCBA), foundations and private companies.
Ongoing Projects	Environmental Diagnosis of the Metropolitan Area of Buenos Aires; The La Plata River as a Territory

Other Activities	Teaching of graduate and extension courses
Web Site	http://www.fadu.uba.ar/isu/index.htm

Name of Institution	**Laboratorio de Climatología Regional (Regional Climatology Lab)**
Unit	Atmosphere and Ocean Sciences Department, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Ongoing Projects	AIACC 26: Impact of global change on the coastal areas of the La Plata River: sea level rise and meteorological effects; Genesis, Socioeconomic Cost, Adaptation and Prevention (UBA Strategic Project)
Web Site	http://www-atmo.at.fcen.uba.ar/~lcr/

Name of Institution	**Centro de Investigaciones del Mar y la Atmósfera – CIMA (Sea and Atmosphere Research Centre)**
Unit	Atmosphere and Ocean Sciences Department, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA) and CONICET (National Science and Technical Council)
Location	City of Buenos Aires, Argentina
Research Areas	Climate Modelling; Climate Variability at regional and large scale; Synoptic Meteorology; Circulation sensitivity to atmospheric forcing factors in the South Atlantic and the Argentine basin; Effects on regional climate due to natural and anthropogenic causes; Cyclonic systems in high latitudes
Ongoing Projects	Development of a Collaborative Research Network for the Study of Regional Climate Variability and Changes, their Prediction and Impact in the Mercosur Area. (IAI-ANPCyT - National Agency for the Promotion of Science and Technology); Estuaries as Synthesis Elements for Environmental Management at Continental Level: A Case Study in the La Plata River (ANPCyT); Study on Climate Variability in South America (UBA); Implementation and Validation of a Three-Dimensional Model of Water Circulation in the La Plata River and the Adjacent Continental Platform (ANPCyT); Oceanographic Research Studies of the La Plata River. An Argentine-Germany collaboration project. Sponsoring organisations: Binational Cooperation Project, SETCIP (Department of Technology, Science and Productive Innovation), BMBF (Germany); Climatology of Extreme Rainfall and Temperature in the South Area of South America. Climate Risk Estimation. Climatic-Synoptic Aspects (UBA); Droughts in Argentina (ANPCyT); Study of Atmospheric and Soil Conditions Leading to Flood Events in the Paraná River Using Remote Sensor Data (UBA and CONICET); Meteorologic Models Applied to Agriculture and Human Health (UBA)
Web Site	http://www.cima.fcen.uba.ar/

Name of Institution	**Departamento de Ciencias Geológicas , Área de Hidrogeología (Department of Geological Sciences, Hydrogeology Area)**
Unit	Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Ongoing Projects	Guaraní Aquifer System: A Resource Shared by Argentina, Brazil, Paraguay and Uruguay; Vulnerability to Nitrate Contamination in the Puelche Aquifer System in La Plata, Argentina; Hydrogeological Research of the City of Buenos Aires.
Other Activities	Teaching of undergraduate programme courses.
Web Site	http://www.gl.fcen.uba.ar/grinv.htm

Name of Institution	**Grupo de Investigación en Ecología de Humedales – GIEH (Wetlands Ecology Research Group)**
Unit	Department of Ecology, Genetics and Evolution, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Research Areas	Research on different ecological aspects of wetland ecosystems at various spatial and time scales, having focused most studies on the Paraná River Delta Region. The focus on the study of this type of ecosystems is given by the importance of wetlands not only as a source of goods and services for humans, but also due to their ecological values and functions.
Ongoing Projects	Guaraní Aquifer System: A Resource Shared by Argentina, Brazil, Paraguay and Uruguay; Vulnerability to Nitrate Contamination in the Puelche Aquifer System in La Plata, Argentina; Hydrogeological Research of the City of Buenos Aires.
Other Activities	Teaching of undergraduate, graduate and extension courses.
Web Site	http://www.ege.fcen.uba.ar/Htmls/grupos/grupo9/index.htm

Name of Institution	**Grupo de Limnología (Limnology Group)**
Unit	Department of Ecology, Genetics and Evolution, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Research Areas	Analysis of algal biodiversity in continental aquatic environments; Trophic levels studies using manipulative experiments; Analysis of phytoplankton and periphyton structure and dynamics; Studies on water quality and characterisation of species and/or indicator associations;

	Taxonomic studies supported by different techniques.
Ongoing Projects	Study on Lentic and Lotic Environments in the Floodplain of the Lower Paraná River
Other Activities	Teaching of undergraduate, graduate and extension courses.
Web Site	http://www.ege.fcen.uba.ar/grupos/limnologia/index.htm

Name of Institution	**Instituto de Química-Física de Materiales, Medio Ambiente y Energía – INQUIMAE (Materials Physical Chemistry, Environment and Energy Institute)**
Unit	Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA) and CONICET
Location	City of Buenos Aires, Argentina
Research Areas	Environmental studies related to atmospheric pollution, chemistry of water and soil contaminants and trace analysis
Services to Third Parties	Instrument analysis services; Services Contracts and highly-qualified advisory assistance; Consultation to up-to-date high chemistry technology professionals
Other Activities	Refresher Training Courses delivered by their researchers, international visitors and instrument suppliers.
Web Site	http://www.inquimae.fcen.uba.ar/

Name of Institution	**Instituto de Investigación Gino Germani (Gino Germani Research Institute)**
Unit	Urban Studies Area, Facultad de Ciencias Sociales, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Ongoing Projects	Instruments for the Reduction of Flood Risks in the City of Pergamino
Web Site	http://www.iigg.fsoc.uba.ar/index.htm

Name of Institution	**Instituto de Geografía "Romualdo Ardissone ("Romualdo Ardissone" Geography Institute)**
Unit	Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Research Areas	Natural Resources and Environment; Spatial Analysis of Basins

Ongoing Projects	
Other Activities	Teaching of undergraduate and graduate courses
Web Site	http://www.filo.uba.ar/contenidos/investigacion/institutos/geografia/homepage.htm

Name of Institution	**Centro de Investigación en Estudios Transdisciplinarios del Agua (Research Centre for Water Transdisciplinary Studies)**
Unit	Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (UBA)
Location	City of Buenos Aires, Argentina
Services to Third Parties	Technical assistance (environmental impact assessment; environmental auditing and consulting services; stabilisation lagoons, mitigation of environmental adverse effects due to productive activities; quality of water intended for various purposes; groundwater pollution assessment; nutrients in surface waters; phytoremediation), Lab Analysis
Ongoing Projects	Biogeochemical Processes in the Salado River Lower Basin (UBA); Anthropic Influence on Aquatic Ecosystems and Wetlands. Anthropic Water Cycle in Agricultural Production Systems (UBA)
Other Activities	Training (Master's Degree in Water Management)
Web Site	http://www.cyted.agua.uba.ar/ceta/index.html

Name of Institution	**Programa de Investigación, Desarrollo y Asistencia con Instituciones Asociadas (Research, Development and Assistance Programme with Associate Institutions)**
Unit	Universidad Nacional de General San Martín
Location	General San Martín District, Province of Buenos Aires, Argentina
Ongoing Projects	Contaminant Mobilisation in Natural Systems (Water and Soils))
Web Site	http://www.unsam.edu.ar/webunsam/ep/home.php?cmd=invest.pida5s

Name of Institution	**Instituto de Ciencias (Sciences Institute)**
Unit	Universidad Nacional de General Sarmiento
Location	General Sarmiento District, Province of Buenos Aires, Argentina
Research Areas	Environmental Chemistry

Ongoing Projects	Influence of the Complexing Capacity of the Medium on the Remediation of Heavy-Metal Contaminated Waters Using Autonomous Microorganisms; Determination of the Environmental Impact of Pesticides Used in Periurban Agricultural Practices
Other Activities	First University Cycle, graduate programme activities
Web Site	http://www.ungs.edu.ar/ici/index.htm

Name of Institution	**Instituto del Conurbano (Institute of the Suburbs)**
Unit	Universidad Nacional de General Sarmiento
Location	General Sarmiento District, Province of Buenos Aires, Argentina
Research Areas	Modern City Issues, particularly in the Metropolitan Buenos Aires Region Urban Ecology
Ongoing Projects	Integrated Management of Basins in the Metropolitan Buenos Aires Region. Georeferencing of Data on Basin Status and Analysis of Ecological Sustainability; Reinforcement of the Municipal Environmental Management of San Antonio de Areco. Analysis and Drafting of Proposals for Water Resource and Urban Solid Waste Management (CIC, Scientific Research Commission)
Other Activities	Teaching of undergraduate courses.
Web Site	http://www.ungs.edu.ar/ico/index.htm

Name of Institution	**Laboratorio de Hidráulica Marítima y Fluvial (Maritime and Fluvial Hydraulics Lab)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad de Buenos Aires (UBA)
Location	City of La Plata, Province of Buenos Aires, Argentina
Web Site	http://www.ing.unlp.edu.ar/decanato/seccyt/index.htm

Name of Institution	**Laboratorio de Hidrología (Hydrology Lab)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Web Site	http://www.ing.unlp.edu.ar/decanato/seccyt/index.htm

Name of Institution	**Laboratorio de Ingeniería Sanitaria (Sanitary Engineering Lab)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Web Site	http://www.ing.unlp.edu.ar/decanato/seccyt/index.htm

Name of Institution	**Laboratorio de Hidromecánica (Hydromechanics Lab)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Web Site	http://www.ing.unlp.edu.ar/decanato/seccyt/index.htm

Name of Institution	**Unidad de Investigación, Desarrollo y Docencia Gestión Ambiental (Development and Teaching Research Unit - Environmental Management)**
Unit	Hydraulics Department, Facultad de Ingeniería, Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Web Site	http://www.ing.unlp.edu.ar/decanato/seccyt/index.htm

Name of Institution	**Facultad de Ciencias Agrarias (Agricultural Sciences School)**
Unit	Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Services to Third Parties	*Soil and Water Analysis Lab:* Assessment and Diagnosis of Soil for Production, Landscaping, Recreational and Environmental Preservation purposes. Water: Water quality for animal drinking and irrigation purposes; pH and electrical conductivity; Determination of $CO_3^{=}$, CO_3H^-, $SO_4^{=}$, Cl^-, B, Ca, Mg, K, Na
Ongoing Projects	Basin Studies to determine their Degradation due to Water Erosion and its Influence on Soil Use; Interactions of Water Stress and Competition and Photosynthesis Parameters of the Zea Mays-Sorghum Halepense A+ssociation; Land Arrangement in Basins. Its application to Environmental Degradation due to Surface Water Erosion; Salinity and Sodicity Changes in some Argiudol and Hapludol Soils of the Pampas which are supplementarily irrigated with Sodium Bicarbonated Groundwater; Design, Management and Assessment of Sustainable

	Agricultural Systems
Other Activities	Basin Management Course (Chemical Analysis Programme Course)
Web Site	http://www.agro.unlp.edu.ar/

Name of Institution	**Centro de Investigaciones del Medio Ambiente – CIMA (Environmental Research Centre)**
Unit	Department of Chemistry, Facultad de Ingeniería, Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Research Areas	Research and Development in environmental areas related to Ecotoxicology and Environmental Chemistry, especially focused on environmental diagnosis and risk assessment; Human Resources Training
Services to Third Parties	Determination of Physiochemical and ecotoxicologic parameters; Environmental impact and risk assessment, expert assessments.
Ongoing Projects	Agrochemical Impact in the Lower Paraná River and the La Plata River Basins (Scientific Promotion Agency)
Other Activities	Instructions for doctorate and masters programmes thesis; occupational experience practices for undergraduate students, and teaching of graduate programme courses
Web Site	http://www.unlp.edu.ar/cima/index.html

Name of Institution	**Investigaciones de Suelos y Aguas de Uso Agropecuario – CISAUA (Research on Soils and Waters for Agricultural Purposes)**
Unit	Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Web Site	http://www.fcnym.unlp.edu.ar/

Name of Institution	**Laboratorio de Investigación de Sistemas Ecológicos y Ambientales - LISEA (Ecological and Environmental Systems Research Lab)**
Unit	Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata (UNLP)
Location	City of La Plata, Province of Buenos Aires, Argentina
Research Areas	Forest Ecology, Ecology of Pastureland, Urban Ecology
Web Site	http://www.fcnym.unlp.edu.ar/

Name of Institution	Laboratorio de Hidráulica (Hydraulics Lab)
Unit	Universidad Nacional de Lomas de Zamora (UNLZ)
Location	Lomas de Zamora, Province of Buenos Aires, Argentina
Web Site	http://www.fi-unlz.org.ar/

Name of Institution	Departamento de Ciencias Básicas (Department of Basic Sciences)
Unit	Universidad Nacional de Luján (UNLU)
Location	Luján, Province of Buenos Aires, Argentina
Research Areas	Ecoecology and fauna conservation; aquatic ecology; applied ecophysiology; ecotoxicology
Services to Third Parties	Assistance to companies and national public organisations through the "Fondo Argentino de Cooperación Horizontal del Ministerio de Relaciones Exteriores" (Argentine Horizontal Cooperation Fund within the Ministry of Foreign Affairs); technical collaboration services to universities and official organisations of Latin America
Ongoing Projects	*Ecotoxicology and Fauna Conservation:* Environments of the Luján River: Their Characterisation Applying Remote Detection Techniques and Geographic Information Systems; Fauna of the Luján River: Assessment of the Conservation Status and Ecoethology of River Mammals. *Aquatic Ecology Programme:* Ecology of the Luján River Basin; Study of the Effect of Pollution on Invertebrates of the Benthonic Animal Communities in Streams of the Pampas Plain; Ecology of the Luján River Basin. Study on Gastropods Associated to Macrophytes; Metabolism of Two Tributary Streams of the Luján River; Ecological Regionalisation of Streams of the Province of Buenos Aires. *Applied Ecophysiology Programme:* Ecotoxicologic Assessment of the Reconquista River; Stress Assessment of Fish Exposed to Cadmium Using Markers; Chemical Speciation: Its Influence on the Toxicity of Heavy Metals in a Water Medium; Biomarkers of Water Pollution; Monitoring of Environmental Variables Using SAC-C MMRS Images and MODIS-Terra in the Region; SPOT Panchromatic Images and Business SIG as Tools for Decision-Making in Companies Located in the Luján River Basin.
Other Activities	Delivery of training courses for teachers and professionals on the various scientific disciplines they deal with. This Department, through the Federal Network of Teacher Continuing Education, also contributes to the advancement of high-school and non-university higher-education teachers
Web Site	http://www.unlu.edu.ar/basicas

Name of Institution	Departamento de Ciencias Sociales (Department of Social Sciences)

Unit	Universidad Nacional de Luján (UNLU)
Location	Luján, Province of Buenos Aires, Argentina
Research Areas	Major areas in which this Department is conducting research comprise topics such as economic, social and demographic history and structure of the region and the Province of Buenos Aires; environmental issues, women-related, health and nutrition issues
Ongoing Projects	Bases for the Development of an Environmental Information System; Environmental Impact Introduction in Argentina, 1970-1988, The role of Social Sciences; Conceptual Model and Indicator System for Environmental Management and Monitoring; Foreign Debt and Environmental Issues.
Other Activities	Teaching
Web Site	http://www.unlu.edu.ar/~sociales/

Name of Institution	**Departamento de Tecnología (Technology Department)**
Unit	Universidad Nacional de Luján (UNLU)
Location	Luján, Province of Buenos Aires, Argentina
Research Areas	Food, Industrial and Agronomic Engineering; Information Systems
Services to Third Parties	Assistance to industrial and agricultural companies regarding process and product engineering, development of new processes and products, quality assurance, pollution, environmental sanitation and protection, technical services to organisations, companies and individuals regarding chemical, microbiological and agronomic analyses.
Ongoing Projects	Corn Dehydration; Climatic and Agroclimatic Characterisation of the Luján River Basin; Water Consumption of Greenhouse Horticultural Crops in the Warm and Humid Area of Argentina.
Other Activities	Technical Courses and Conferences
Web Site	http://www.unlu.edu.ar/tecnologia

Name of Institution	**Grupo de Ecología Matemática (Mathematical Ecology Group)**
Unit	Facultad de Ciencias Exactas, Universidad Nacional del Centro de la Provincia de Buenos Aires (UNICEN)
Location	Tandil, Province of Buenos Aires, Argentina
Research Areas	Development of different tools and models: hydrologic models, dynamic vegetation maps and community models of several macrovertebrate species

Ongoing Projects	The Sustainable Management of Wetland in Mercosur. INCO DC EC Project
Web Site	http://www.exa.unicen.edu.ar/investigacion/ecolmate.htm

Name of Institution	**Instituto de Hidrología de Llanuras - IHLLA (Institute of Plains Hydrology)**
Unit	Facultad de Agronomía, Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCEN)
Location	Azul, Province of Buenos Aires, Argentina
Research Areas	
Web Site	http://www.unicen.edu.ar/

Name of Institution	**Centro de Investigaciones Geográficas – CIG (Centre of Geographic Research)**
Unit	Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCEN)
Location	Tandil, Province of Buenos Aires, Argentina
Research Areas	The integration core of current research areas is the geographic perspective for local and regional development. Other topics include Population and Environment
Ongoing Projects	Population, Quality of Life and Environment in Argentina (SIG and analysis scales).
Web Site	http://www.fch.unicen.edu.ar/institutos.htm

Name of Institution	**Núcleo Regional de Estudios Socioculturaes – NuRES (Regional Nucleus of Sociocultural Studies)**
Unit	Facultad de Ciencias Sociales, Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCEN)
Location	Olavarría, Province of Buenos Aires, Argentina
Research Areas	Ideology and Government: Environmental Policy in the Province of Buenos Aires
Web Site	http://www.soc.unicen.edu.ar/index1.htm

Name of Institution	**Centro de Investigaciones Ecológicas y Ambientales – CINEA (Ecologic and Environmental Research Centre)**
Unit	Facultad de Ciencias Humanas, Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCEN)

Location	Tandil, Province of Buenos Aires, Argentina
Research Areas	Environmental diagnosis, planning and management to get in-depth knowledge of the structure, operation and dynamics of systems resulting from the society-nature interrelation.
Services to Third Parties	City development, tourist activities, environmental impact assessment, environmental auditing, environmental laws, geological, geomorphological and water resources, environmental sanitation, industrial safety and health, environmental education and training, geographic information systems
Ongoing Projects	City Environmental Sustainability Indicators
Other Activities	Human resources training
Web Site	http://www.fch.unicen.edu.ar/institutos.htm

Name of Institution	**Centro Integral de Estudios de Grandes Ríos –CIEGRI (Comprehensive Study Centre of Great Rivers)**
Unit	Facultad de Ingeniería y Ciencias Hídricas, Universidad Nacional del Litoral (UNL)
Location	Santa Fe, Argentina
Research Areas	Enhance the development of knowledge on and the assessment, use and preservation of great river systems, by contributing to the consolidation of topic core areas that are being developed and the inclusion of new research areas, and fostering the formation of interdisciplinary work groups which will help, with the support of the human resources and materials of the Universidad Nacional del Litoral, address in a comprehensive way the management of and the problems involved in worldwide great rivers
Web Site	http://www.fich.unl.edu.ar

Name of Institution	**Centro Nacional de Estudios Hidroambientales CENEHA (National Centre of Hydroenvironmental Studies)**
Unit	Facultad de Ingeniería y Ciencias Hídricas, Universidad Nacional del Litoral (UNL)
Location	Santa Fe, Argentina
Research Areas	This Centre consists of two groups: 1) The Quaternary Study Group (Grupo de Estudios del Cuaternario, GEC), whose goal is to conduct research and collect field evidence of the most important formation process of the earth surface of most of Argentina during this period; 2) The Hydroenvironmental Study Group (Grupo de Estudios Hidroambientales , GEHA), whose goal is to conduct basic and applied research on rivers and surface and groundwater hydrology for the purpose of contributing to engineering problem-solving within the current

	socioeconomic context of the country by understanding major environmental processes. These groups carry out lab experiments, field studies, theoretical, and numerical modelling/simulation developments.
Other Activities	The GEHA is also one of the major mainstays of the Engineering Doctorate Programme, specialised in Water Resources.
Web Site	http://www.fich.unl.edu.ar

Name of Institution	**Centro de Informaciones Meteorológicas – CIM (Meteorological Information Centre)**
Unit	Facultad de Ingeniería y Ciencias Hídricas, Universidad Nacional del Litoral (UNL)
Location	Santa Fe, Argentina
Research Areas	It reports to the Department of Hydrology and operates a hydrometeorological station and has an electronics repair shop for instrument reparation and calibration, in addition to all necessary IT equipment. It conducts research on the development of hydrometeorological instruments, special services regarding instrument calibration lab jobs and the maintenance of the hydrometeorological station mounted on the university campus premises, and regional interest extension services by elaborating the meteorological and hydrometeorological forecasts for the region
Services to Third Parties	Pursuant to an agreement made with the Ministry of Agriculture, Cattle Raising, Industry and Commerce (MAGIC) of the Province of Santa Fe, it operates the Single Database to record any information generated. It is also actively collaborating with the Department of Communications of the Province of Santa Fe, collecting data from nearly 400 rainfall-metering stations to make the generated data valid.
Other Activities	Teaching of undergraduate and graduate programme courses.
Web Site	http://fich.unl.edu.ar/cim

Name of Institution	**Sistema Meteorológico del Litoral- SIMELIT (Meteorological System of the Littoral Region)**
Unit	Facultad de Ingeniería y Ciencias Hídricas, Universidad Nacional del Litoral (UNL)
Location	Santa Fe, Argentina
Research Areas	It operates within the scope of the Hydroclimatic Research Unit of the FICH-UNL (UNL School of Engineering and Water Sciences) and is included in an integral extension and integration process between the University and the people. There are three major research areas: climate variability and change; climate prediction; and atmosphere-aquifer interaction
Web Site	http://www.fich.unl.edu.ar

Name of Institution	Facultad de Ciencias Exactas, Ingeniería y Agrimensura
Unit	Universidad Nacional de Rosario (UNR)
Location	Rosario, Province of Santa Fe, Argentina
Ongoing Projects	Applicability of Infiltration Techniques for Rainwater Drainage in Urban Areas of the Undulated Pampas Region; Surface Water Excess in Hydrologic Systems of Plains; Modelling of Sediment Generation at Basin Scale in Hydrologic Systems of Plains; Water Resources Planning Using Computer Methods; Methodological Systematisation for Integrated Management of Basins in Plains Areas; Determination of Ecologic Areas. Environmental Impact of Extremely Large Projects – Rosario; Adequate Technology for Water and Liquid Waste Treatment.
Web Site	http://www.fceia.unr.edu.ar/labinfo/inv_extension/proyectos

Name of Institution	Instituto de Fisiografía y Geología (Physiography and Geology Institute)
Unit	Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario (UNR)
Location	Rosario, Province of Santa Fe, Argentina
Research Areas	Basic and applied research targeted to the study of the Chaco-Pampas Plain, specially focused on a wide area comprising the Province of Santa Fe and other neighbouring provinces with the aim to understanding internal and external phenomena of the earth's crust (Geology) that affect surface relief (Physiography).
Services to Third Parties	Advice and assistance to professionals, researchers and companies, in addition to municipal governments and towns of the Province of Santa Fe and the Province of Cordoba, regarding topics such as water resources assessment and geomorphic studies of basins in plains areas, among others.
Web Site	http://www.fceia.unr.edu.ar/labinfo/info_academica/institutos/fisiografia_geolog.html

Name of Institution	Centro de Ingeniería Sanitaria (Sanitary Engineering Centre)
Unit	Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario (UNR)
Location	Rosario, Province of Santa Fe, Argentina
Research Areas	Basic Sanitation Issues: drinking water, sewage and solid waste, industrial liquid waste treatment and studies of water quality in surface streams
Services to Third Parties	Water Chemistry and Microbiology Lab (Physical, chemical and microbiological analysis of water for human consumption; physical, chemical and microbiological analysis of water for irrigation purposes;

	physical, chemical and microbiological analysis of water for cattle drinking purposes); Sewage and Industrial Liquid Waste (Characterisation, physical, chemical and microbiological analysis, treatability and toxicity tests; characterisation of sewage sludge); Technical Assistance Services
Ongoing Projects	Biological Removal of Iron and Manganese. Purification of Water with Iron and Manganese Content Using Bioxidation Processes.
Web Site	http://www.fceia.unr.edu.ar/labinfo/info_academica/centros/sanitaria.html

Name of Institution	**Escuela de Ingeniería Civil (Civil Engineering School)**
Unit	Facultad de Ciencias Exactas, Ingeniería y Agrimensura, Universidad Nacional de Rosario (UNR)
Location	Rosario, Province of Santa Fe, Argentina
Research Areas	Even if the major role of the Civil Engineering School is to train future professionals of this area, it is also particularly significant because it has research groups employing individuals of recognised international importance.
Other Activities	Teaching of graduate programmes and courses
Web Site	http://www.fceia.unr.edu.ar/labinfo/info_academica/escuelas/civil/civil.html

Name of Institution	**Centro de Estudios del Ambiente Humano – CEAH (Centre of Human Environment Studies)**
Unit	Facultad de Arquitectura, Planeamiento y Diseño, Universidad Nacional de Rosario (UNR)
Location	Rosario, Province of Santa Fe, Argentina
Ongoing Projects	Analysis and Design of a Sustainable Environment; Sustainable Human Settlements.
Web Site	http://www.fapyd.unr.edu.ar/investigacion/index.htm

Name of Institution	**Facultad de Ciencias Agrarias (Agricultural Sciences School)**
Unit	Universidad Nacional de Rosario (UNR)
Location	Rosario, Province of Santa Fe, Argentina
Ongoing Projects	Use of Energy in Rural Lands of the Ludueña Stream Basin, Santa Fe; Assessment of Extreme Rainfall Events Using the Updated Palmer and the Standardised Rainfall Indexes, and the Relationship to Agricultural Production in the South Area of Santa Fe
Web Site	http://www.fcagr.unr.edu.ar/investigacion.htm#0

Name of Institution	**Facultad de Ciencias Agropecuarias (Agricultural Sciences School)**
Unit	Universidad Nacional de Entre Ríos (UNER)
Location	Paraná, Province of Entre Rios, Argentina
Ongoing Projects	Systematisation of Information on Resources for Sustainable Development Management in Maria Grande, Hasemkamp, Tabossi and Viale, and their corresponding Areas of Influence; Description of Environment Units and Digital Cartography of the Paraná River Pre-Delta; Agrohydrologic Assessment of Irrigation Water Storage Dams in Entre Ríos; Ecological and Environmental Characterisation of Irrigation Dams in Entre Ríos. Providencia
Web Site	http://www.fca.uner.edu.ar/investigacion/investigacion.htm

Name of Institution	**Departamento de Hidráulica (Department of Hydraulics)**
Unit	Facultad de Ingeniería, Universidad Nacional del Nordeste (UNNE)
Location	Resistencia, Province of Chaco, Argentina
Other Activities	Delivery of courses and seminars
Web Site	http://ing.unne.edu.ar/agua/agua.htm

Name of Institution	**Instituto de Ictiología del Nordeste – INICNE (Ichthyology Institute of the Northeastern Region)**
Unit	Facultad de Ciencias Veterinarias, Universidad Nacional del Nordeste (UNNE)
Location	Corrientes, Province of Corrientes, Argentina
Research Areas	*Ichthyopathology:* Histopathology; Parasitology; Bacteriology; Health *Fish Breeding:* Reproduction; Fish Breeding and Stocking; Feeding; Nutrition; Management *Aquatic Toxicology:* Toxicity Tests; Pollution *Ecology:* Biology of Communities; Natural Feeding; Environmental Impact; Fishing Biology
Services to Third Parties	Advice, technical assistance and extension services in the areas of Pathology, Fish Breeding, Toxicology and Health
Ongoing Projects	Modelling of the "Dorado" (*Salminus Maxillosus*) Habitat in the Corrientes and Santa Lucía Rivers Basins (Province of Corrientes); Assessment of Downstream Fishery Resources of the Yacyretá Dam; Analysis of Taxonomic and Functional Diversity Determining Factors of the Ichthyologic Fauna in the Iberá Marshes; Preparation and Validation of a Habitat Model for the Growth of "Dorados" (*Salminus Maxillosus*) in

	the Iberá Marshes).
Web Site	http://vet.unne.edu.ar/inicne/index.htm

Name of Institution	**Instituto de Investigaciones Tecnológicas para el Diseño Ambiental del Hábitat Humano – ITDAHU (Technological Research Institute for the Environmental Design of the Human Habitat)**
Unit	Facultad de Arquitectura y Urbanismo, Universidad Nacional del Nordeste (UNNE)
Location	Corrientes, Province of Corrientes, Argentina
Web Site	http://arq.unne.edu.ar/

Name of Institution	**Equipo Interdisciplinario de Proyectos Ambientales (Environmental Project Interdisciplinary Team)**
Unit	Facultad de Ingeniería, Universidad Nacional de Río Cuarto (UNC)
Location	Río Cuarto, Province of Córdoba, Argentina
Web Site	http://www.ing.unrc.edu.ar/grupos/index.htm

Name of Institution	**Centro de investigaciones Geoquímicas y Procesos de la Superficie (Geochemical and Surface Process Research Centre)**
Unit	Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba
Location	Córdoba, Province of Córdoba, Argentina
Research Areas	Geochemistry of natural surface and groundwater; Paleolimnology
Services to Third Parties	
Ongoing Projects	Amancay. Interannual and Decadal Climate Change in tropical South America: Regional variability at large scale? Towards an integral approach. Region 4: Paraná-Plata Basin
Other Activities	Teaching of undergraduate and graduate courses
Web Site	http://www.efn.unc.edu.ar/investigacion/ciges/pagina1.htm

Name of Institution	**Laboratorio de Hidráulica (Hydraulics Lab)**
Unit	Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba

Location	Córdoba, Province of Córdoba, Argentina
Services to Third Parties	It carries out hydrometering instrument reparation and calibration jobs and provides technical services specialised in Hydraulics.
Ongoing Projects	Analysis and Hydrological Simulation of the Mar Chiquita Lagoon – Dulce River Marshlands System; Hydrometeorological and Meteorological Network; ECOSUD, Bases and Tools for More Sustainable Development of Estuaries and Coastal Areas; Study on the Hydrodynamics, Euthrofication and Evolution of Water Quality in Water Supply Reservoirs for the Greater Córdoba Area
Other Activities	Teaching
Web Site	http://www.efn.uncor.edu/investigacion/hidraulica/

Name of Institution	**Instituto de Estudios Geográficos (Geographic Studies Institute, IEG)**
Unit	Facultad de Filosofía y Letras
Location	Tucumán, Province of Tucumán, Argentina
Research Areas	Population and Environment in Tucumán Programme; Socioenvironmental Bases for Urban Development in Tucumán Programme
Services to Third Parties	The IEG newspaper archive is intended to become an important "Documentation Centre of the Argentine Northwestern Region (NOA)", for the purpose of supporting the role of researchers, teachers, students, and professionals related to the programmes and other research centres of the National University of Tucumán (UNT), government institutions, etc.
Other Activities	Graduate activities, including the organisation and delivery of graduate courses, the generation and management of Master and Doctorate's Programmes Theses
Web Site	http://www.filo.unt.edu.ar/centinti/ieg/ieg_principal.htm

Name of Institution	**Instituto de Aguas Subterráneas para Latinoamérica –INASLA (Institute of Groundwater for Latin America)**
Unit	Facultad de Ciencias Naturales, Universidad Nacional de Salta (UNSA)
Location	City of Salta, Salta, Argentina
Research Areas	Diagnosis of Availability of Water Resources; Regional Prospecting of Groundwater; Geoelectrical Prospecting; Geophysical Profiles of Wells; Identification and Assessment Studies of Water Supply Sources; Prefeasibility Studies for Well Drilling; Technical Management and Supervision of Well Drilling; Prefeasibility and Feasibility Studies and Executive Horizontal Drainage and Infiltration Galleries Projects; Pumping Tests; Regional Assessment of Groundwater Reservoirs;

	Hydrogeological Systems Simulation Using Mathematical Models; Piezometric Level Monitoring; Pollution Studies; Hydrochemical Quality Monitoring.
Services to Third Parties	The research and extension jobs requested by industry institutions have been channeled through the Department of Technical Cooperation and Facultad de Ciencias Naturales de la Universidad Nacional de Salta (the Natural Sciences School of the National University of Salta). The Institute is currently carrying out some jobs for Aguas de Salta (Salta Water Supply Company) and for the Instituto de Asuntos Indígenas de la Nación (the National Institute of Indigenous Affairs).
Ongoing Projects	HIDROLAJITAS: Hoja Hidrogeológica Las Lajitas 1:250.000 (UNSA y Universidad de Tübingen) (HIDROLAJITAS: Las Lajitas Hydrogeological Sheet 1:250,000 (UNSA (National University of Salta) and University of Tübingen))
Other Activities	Teaching of graduate courses. Centre for scientist, internship and conference visitors, Grants and Publications.
Web Site	http://www.unsa.edu.ar/inasla/

Name of Institution	**Instituto de Ecología y Ambiente Humano – INEAH (Institute of Ecology and Human Environment)**
Unit	Facultad de Ciencias Naturales, Universidad Nacional de Salta (UNSA)
Location	City of Salta, Salta, Argentina
Research Areas	Humans-Nature Relationships; Environmental Engineering; Ecology and Conservation; Environment and Quality of Life.
Services to Third Parties	It provides services to third parties.
Ongoing Projects	Contaminated River Environments Recovery Using Native Species (FONCyT [Scientific and Technological Research Fund] and CONICET)
Other Activities	Teaching of graduate courses.
Web Site	http://www.unsa.edu.ar/~ineah/

Name of Institution	**Instituto de Bio y Geociencias del NOA – IBIGEO (Institute of Bio and Geosciences of the Argentine Northwestern Region)**
Unit	Facultad de Ciencias Naturales, Universidad Nacional de Salta (UNSA)
Location	City of Salta, Salta, Argentina
Research Areas	Discovery and study of a wide range of natural resources wealth, including water resources.
Services to Third Parties	
Ongoing Projects	Biology, Diversity and Distribution of Fish in the Province of Salta (Consejo de Investigación de la Universidad Nacional de Salta – Research

	Council of the National University of Salta); Livestock and Native Fauna: Changes Affecting Predation and Secondary Dispersal of Woody Plant Species Seed in the Semiarid Chaco Woodland, Copo National Park and Surroundings, Argentina (Wildlife Conservation Society's Research Fellowship Programme, USA)
Other Activities	Teaching of graduate courses.
Web Site	http://www.unsa.edu.ar/ibigeo/

Name of Institution	**Grupo de Estudios sobre Impacto Ambiental – GESIA (Environmental Impact Study Group)**
Unit	Facultad Regional Haedo, Universidad Tecnológica Nacional
Location	Haedo, Province of Buenos Aires, Argentina
Research Areas	
Services to Third Parties	Certificate of Environmental Compliance; Implementation and Management of ISO 14000 Standard Certification; Preparation of Category Application Forms; Environmental Impact Studies; Environmental Auditing; Advice and Management to obtain certificates of environmental compliance; Special Wastes; Dealings to obtain waste dumping permits; Gaseous Waste (sampling and analysis; preparation and filing of the Annual Affidavit); Optimisation and correction of waste treatment processes. Minimisation of waste; Legal assistance and representation; Industrial Waste Treatment Plants Projects, Construction Works Management, Start-Up, Operation and Maintenance.
Other Activities	Training courses on environmental issues
Web Site	http://www.frh.utn.edu.ar/investigacion/grupos/gesia/index.htm

Name of Institution	**Grupo de Ingeniería Civil (Civil Engineering Group)**
Unit	Technological Centre, Facultad Regional General Pacheco, Universidad Tecnológica Nacional (UTN)
Location	Haedo, Province of Buenos Aires, Argentina
Research Areas	Group members are UTN staff professors employed full-time at the Facultad Regional Gral Pacheco, with broad academic knowledge and a significant professional background in the private sector, specialised in Hydraulic Engineering, etc.
Services to Third Parties	Civil works such as Hydraulic Works Projects; Technical and Economic Prefeasibility and Feasibility Studies; Study and Analysis of Materials; Scheduling, Inspection and Monitoring of Works; Special Tests and Analysis Labs

Web Site	http://cetec.frgp.utn.edu.ar/secciones/grupos/ing_civil/index.htm

Name of Institution	**Polo de Energía y Medio Ambiente – GESE (Energy and Environmental Centre)**
Unit	Technological Centre, Facultad Regional General Pacheco, Universidad Tecnológica Nacional (UTN)
Location	Haedo, Province of Buenos Aires, Argentina
Services to Third Parties	Environmental Quality and Sanitary Engineering Consulting Services in areas such as Sanitary and Environmental Engineering Projects; Environmental Impact Assessment; Environmental Auditing; Treatment Plants; Hazardous Waste
Web Site	http://cetec.frgp.utn.edu.ar/secciones/grupos/polo_de_energia_y_medio_ambiente/index.htm

Name of Institution	**Grupo de Sistemas de Emergencia – SIGEM (Emergency Systems Group)**
Unit	Facultad Regional Delta, Universidad Tecnológica Nacional
Location	Campana, Province of Buenos Aires, Argentina
Web Site	http://www.frd.utn.edu.ar/?opc=Investigacion

Name of Institution	**Grupo de Energía y Ambiente – GIDEA (Energy and Environmental Group)**
Unit	Facultad Regional Delta, Universidad Tecnológica Nacional (UTN)
Location	Campana, Province of Buenos Aires, Argentina
Web Site	http://www.frd.utn.edu.ar/?opc=Investigacion

Name of Institution	**Laboratorio de Aguas (Water Lab)**
Unit	Facultad Regional San Nicolás, Universidad Tecnológica Nacional (UTN)
Location	San Nicolás, Province of Buenos Aires, Argentina
Services to Third Parties	Chemical and bacteriological analysis of water for drinking purposes (supply water) and liquid waste, including the following determinations: Basic organoleptic parameters; chemical parameters; metals; non-metals (by-products); BOD – COD; bacteriological parameters
Web Site	http://www.frsn.utn.edu.ar/frsn/

Name of Institution	**Centro de Emprendimientos y Desarrollos Tecnológicos – CEDE (Centre of Technical Undertakings and Developments)**
Unit	Facultad Regional Venado Tuerto, Universidad Tecnológica Nacional (UTN)
Location	Venado Tuerto, Province of Santa Fe, Argentina
Research Areas	Development and analysis of environmental sanitation programmes in the region by means of the generation, use and scientific development of non-traditional resources that do not affect the ecosystem Research on natural systems purification techniques for solid, liquid or gaseous wastes; development of non-significant environmental impact systems for energy generation; generation, use and development of renewable energy resources
Services to Third Parties	Services in the areas of environmental sanitation and non-traditional energy sources
Ongoing Projects	Wastewater Radicular Treatment; Determination of Design Parameters of a Phytoterrestrial Filter for Household Wastewater; Treatment of Septic Waters by means of Radicular Biological Synthesis
Other Activities	Human resources training
Web Site	http://www.frvt.utn.edu.ar/invesg-cede.html

Name of Institution	**Centro de Estudios Ambientales – CEAM (Environmental Studies Centre)**
Unit	Facultad Regional Venado Tuerto, Universidad Tecnológica Nacional (UTN)
Location	Venado Tuerto, Province of Santa Fe, Argentina
Research Areas	Research and development on the control of contaminants incidence on the environment and the quality of life
Web Site	http://www.frvt.utn.edu.ar/invesg-ceam.html

Name of Institution	**Grupo de Estudio de la Contaminación del río Uruguay – GECRU (Uruguay River Pollution Study Group)**
Unit	Facultad Regional Concepción del Uruguay, Universidad Tecnológica Nacional (UTN)
Location	Concepción del Uruguay, Province of Entre Ríos, Argentina
Ongoing Projects	Study on the Spatial-Time Evolution of Chemical and Bacteriological Indicators of Water Quality in a Section of the Uruguay River
Other Activities	
Web Site	http://www.frcu.utn.edu.ar/investigacion/grupo.php?id_grupo=13

Name of Institution	**Grupo de Estudio del Río Uruguay – GERU (Uruguay River Study Group)**
Unit	Facultad Regional Concepción del Uruguay, Universidad Tecnológica Nacional (UTN)
Location	Concepción del Uruguay, Province of Entre Ríos, Argentina
Ongoing Projects	Study on the Hydrodynamic, Sedimentologic and Morphological Characteristics of the Uruguay River for the Purpose of Improving its Navigability Conditions; Uruguay River Pollution Study
Web Site	http://www.frcu.utn.edu.ar/investigacion/grupo.php?id_grupo=6

Name of Institution	**Grupo de Investigación y Servicios a Terceros en el Área Química – GISTAC (Chemical Research and Services to Third Parties Group)**
Unit	Facultad Regional Resistencia, Universidad Tecnológica Nacional (UTN)
Location	Resistencia, Province of Chaco, Argentina
Services to Third Parties	Physical, chemical and bacteriological analysis of water; physical and chemical analysis of industrial liquid waste
Web Site	http://www.frre.utn.edu.ar/modules.php?name=Investigacion&file=proyectos&func=ProyectosIndex&grupo_invest_id=2

Name of Institution	**Centro de Ingeniería Ambiental – CeDIA (Environmental Engineering Centre)**
Unit	Facultad Regional Resistencia, Universidad Tecnológica Nacional (UTN)
Location	Resistencia, Province of Chaco, Argentina
Ongoing Projects	Critical Environmental Controls in Sewage Sludge Irradiation; Applicability of Wastewater Treatment Plants in Small- and Medium-Sized Population Centres.
Web Site	http://www.frt.utn.edu.ar/scytec/

Name of Institution	**Centro Regional de Investigación y Desarrollo de Santa Fe (CERIDE) (Regional Research and Development Centre of Santa Fe)**
Unit	Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) (National Council of Scientific and Technical Research)
Location	Santa Fe, Province of Santa Fe, Argentina
Research Areas	Environmental Technology; Chemical Engineering; Food Technology
Services to Third Parties	Parameter control of natural waters and wastewater and leachates; Metal content determination in biological matrices; Organic and inorganic parameters in contaminated soils (metals, petroleum hydrocarbons,

	pesticides, etc.); Analysis of organic contaminants (PCB, pesticides and herbicides). Advisory assistance for quality standards implementation and for special projects in fields such as Chemical Engineering, Environmental Technology and Food Technology.
Other Activities	Assistance to all CONICET institutes based in Santa Fe.
Web Site	http://www.ceride.gov.ar/

Name of Institution	**Instituto Nacional de Limnología Aplicada (INALI) (National Institute of Applied Limnology)**
Unit	Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) (National Council of Scientific and Technical Research)
Location	Santa Fe, Province of Santa Fe, Argentina
Research Areas	Physical limnology of continental aquatic environments; ecology of birds associated to the ecosystem of Paraná River flood valley; Biology, ecology and breeding of crustaceans; fishery biology; physical limnology of continental aquatic environments: Physical structure of river habitats; Benthos of the Middle Paraná River and environments of its floodplain; continental waters phytoplankton ecology; taxonomy, biogeography, biology and conservation of snakes of the Paraná River basin; continental waters zooplankton ecology; taxonomy and biogeography of rotifers; Paraná River benthos; ecology and taxonomy of continental waters zooplankton; biology and physiology of neotropical fish; ecotoxicology; fish ecology; ichthyoplankton.
Services to Third Parties	Biological determinations, chemical parameters, physical parameters, environmental impact assessment
Other Activities	It has been teaching the Latin American River Limnology Course since 1992
Web Site	http://www.ceride.gov.ar/institut/inali/inali.htm

Name of Institution	**Centro de Ecología Aplicada del Litoral (CECOAL) (Centre of Applied Ecology of the Littoral)**
Unit	Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) (National Council of Scientific and Technical Research)
Location	Corrientes, Province of Corrientes, Argentina
Research Areas	Paleoecology, paleoclimates and biozoning of continental basins; basins' paleoflora and paleofauna; dendrology; current and fossil palynology; flower origin of regional honey types; atmospheric pollen dynamics; palynology applied to pest control; river systems dynamics; ecology and management of large wetlands; amphibious and parasite communities dynamics; natural biodiversity and disturbance impacts; surface water quality; eutrofication in plains with urban settlements; assessment of river fisheries; environmental disruptions and disturbances.
Services to Third Parties	It provides technical services such as assessments, diagnosis, expert reports

Other Activities	Refresher Training Courses
Web Site	http://www.cecoal.com.ar/

Name of Institution	**Instituto de Limnología "Dr. Raul A. Ringuelet"(ILPLA) (Institute of Limnology "Dr. Raúl A. Ringuelet")**
Unit	Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) (National Council of Scientific and Technical Research)
Location	La Plata, Province of Buenos Aires, Argentina
Research Areas	Biodiversity and Biogeography; Bioindicators (La Plata River, rivers and streams of the Province of Buenos Aires); Ichthyology-Fishery Resources; Aquatic Bacteriology; Limnology of Reservoirs; Studies of biotic communities of rivers and lakes in the Pampasia; Analysis of nutrients and heavy metals in aquatic biota.
Ongoing Projects	*Funded by the CONICET:* Ecological Bases for River Biomonitoring, Northwestern area of Buenos Aires and the La Plata River (FCS) (since 1997); Biodiversity of Diptera Culicidae, Coleoptera and Heteroptera in Limnotopes of the La Plata River Area (since 1998); Ecology, Zoogeography and Biodiversity of South American Continental and Marine Fish (since 1997); Heavy Metals in the Lower Paraná River and the Right Bank of the La Plata River (since 1997). *Funded by other institutions:* Determination of the Ecological Status of Rivers and Streams in the Pampas Region and Monitoring Methodology Based on Macroinvertebrates, Algae and Macrophytes (since 1998); Study of River/Lake Interactions in the Salado River Basin (Buenos Aires) (since 1997); Limnologic Study of the Tercero River Reservoir (since 1996); Prospecting of the Fishery Potential of the Chascomús District for the Land Arrangement of its Lagoons (since 1999); Systematics, Phylogeny and Biogeography of Telmatobius (Anura: Leptodactylidae) Using Morphologic and Molecular Characteristics) (since 1999).
Web Site	http://www.conicet.gov.ar/php/datosue.php4?n=05424

- Private Institutions

Name of Institution	**Laboratorio Ambiental (Environmental Lab)**
Unit	Facultad de Ingeniería, Universidad Católica Argentina
Location	City of Buenos Aires, Argentina
Research Areas	Environmental Studies in Patagonia; Decontamination using electrochemical and biological means; Alternative energy sources
Web Site	http://www2.uca.edu.ar/esp/sec-fingenieria/esp/page.php?subsec=laboratorios&page=ambiental

Name of Institution	Laboratorio de Ingeniería Civil (Civil Engineering Lab)
Unit	Facultad de Ingeniería, Universidad Católica Argentina
Location	City of Buenos Aires, Argentina
Other Activities	Teaching support for specialisation courses of the Civil Engineering Degree Programme; Talks with exhibitors of products used for Civil Engineering jobs.
Web Site	http://www2.uca.edu.ar/esp/sec-fingenieria/esp/page.php?subsec=laboratorios&page=civil

Name of Institution	Facultad Católica de Química e Ingeniería Fray Rogelio Bacon
Unit	Universidad Católica Argentina
Location	Rosario, Province of Santa Fe, Argentina
Services to Third Parties	Environmental Analysis; Chemical and Microbiological Analysis of Waters, Food and Liquid Waste; Special Chemical Studies; Industrial Risk Assessment; ISO 9000 Standards
Web Site	http://www.bacon.org.ar/transferencia.php

Name of Institution	Centro de Investigación, Observación y Monitoreo Territorial y Ambiental (Land and Environmental Research, Observation and Monitoring Centre)
Unit	Facultad de Ingeniería, Geoecología y Medio Ambiente, Universidad Católica de Santa Fe
Location	Santa Fe, Province of Santa Fe, Argentina
Research Areas	To contribute to the generation of conditions to overcome poverty and improve the standard of living of the rural population in the North-Northeastern-Centre of Argentina
Services to Third Parties	
Ongoing Projects	Climate Change and Carbon Drain; Agricultural Management Systems; Climate Change Impact on Natural and Agronomic Ecosystems (European Union Programme)
Web Site	http://www.ciomta.com.ar/home.html

Name of Institution	Instituto de Estudios e Investigaciones Ambientales (Institute of Environmental Studies and Research)
Unit	Universidad de Ciencias Empresariales y Sociales (UCES)
Location	City of Buenos Aires, Argentina
Research Areas	To carry out situational diagnosis regarding environmental issues and provide possible solutions to such issues based on an interdisciplinary

	approach; To make risk and vulnerability mappings; To arrange the natural factors of risk areas in the community in order of importance for identification purposes. To address the issue of chemical emergencies by recruiting human resources so that a proper response is provided based on demand.
Web Site	http://www.uces.edu.ar/institutos/ieia.php

14.2.1.2. Bolivia

- Public Institutions

Name of Institution	**Centro de Análisis, Investigación y Desarrollo (Analysis, Research and Development Centre)**
Unit	Universidad Autónoma Juan Misael Saracho
Location	Tarija, Department of Tarija, Bolivia
Services to Third Parties	It addresses the needs for analysis, technical assistance and research of agricultural, industrial, health, nutrition, basic and environmental sanitation sectors
Other Activities	Support to academic support activities, thesis assignments and graduate degree programme and research jobs
Web Site	http://www.uajms.edu.bo/unidades/laboratorios/servicio/

Name of Institution	**Centro de Investigación y Manejo de Recursos Naturales Renovables (CIMAR) (Renewable Natural Resources Research and Management Centre)**
Unit	Universidad Autónoma Gabriel René Moreno
Location	Santa Cruz de la Sierra, Department of Santa Cruz de la Sierra, Bolivia
Research Areas	Research on renewable natural resources, including those related to Agroclimatology and Hydrology
Services to Third Parties	Technical advisory assistance to the productive sector, such as small producers, communities and private sector companies
Ongoing Projects	
Other Activities	Academic services within the University
Web Site	http://www.uagrm.edu.bo/index_princ.php?opcion=705#

Name of Institution	Unidad de Asistencia Técnica a los Laboratorios (Technical Lab Assistance Unit)
Unit	Universidad Autónoma Gabriel René Moreno
Location	Santa Cruz de la Sierra, Department of Santa Cruz de la Sierra, Bolivia
Research Areas	To reinforce the service capacity of labs at the various levels they act: academic, research and extension levels
Services to Third Parties	Scientific and technical services provided to the community
Web Site	http://www.uagrm.edu.bo/index_princ.php?opcion=701#

Name of Institution	Centro de Investigación, Extensión y Producción Pecuaria "El Prado" (Livestock Research, Extension and Production Centre "El Prado")
Unit	Universidad Autónoma Gabriel René Moreno
Location	Santa Cruz de la Sierra, Department of Santa Cruz de la Sierra, Bolivia
Research Areas	Aquaculture, caprines and sheep; pork, poultry and others. Aquaculture: It is intended to conduct research on artificial reproduction systems for native species in order to integrate fish breeding into the productive activities of the region.
Web Site	http://www.uagrm.edu.bo/index_princ.php?opcion=613

Name of Institution	Laboratorio de Hidráulica (Hydraulics Lab)
Unit	Facultad de Ingeniería, Universidad Autónoma Tomás Frías
Location	Potosí, Department of Chuquisaca, Bolivia
Research Areas	To encourage and promote training of university teachers, alumni and students on Scientific and Technological Research
Web Site	http://www.uatf.edu.bo/dicyt/Inventario%20de%20laboratorios.pdf

Name of Institution	Sistema Boliviano de Tecnología Agropecuaria (SIBTA) (Agricultural and Farm Technology System of Bolivia)
Unit	Ministry of Farm and Agricultural Affairs
Location	La Paz, Bolivia
Research Areas	Planning, promotion and performance of agricultural, forest and agroindustrial technological innovation activities at national level and based on regional needs

Web Site	http://www.sibta.gov.bo/menu.asp?Menu=3&Submenu=0

Name of Institution	**Programa Nacional de Riegos (Componente técnico) (National Irrigation Programme [Technical Component])**
Unit	Ministry of Farm and Agricultural Affairs
Location	La Paz, Bolivia
Research Areas	Development of service delivery capacities in human and institutional resources of public and private organisations that address the preparation, management and execution of community irrigation projects.
Ongoing Projects	Around 30-irrigation assistance projects in the departments located in the La Plata Basin.
Other Activities	Training
Web Site	http://www.catpronar.org/

- Private Institutions

Name of Institution	**Laboratorio de Hidráulica (Hydraulics Lab)**
Unit	Facultad de Ingeniería, Universidad del Valle (Univalle)
Location	Potosí, Department of Chuquisaca, Bolivia
Research Areas	Necessary scientific research and development tasks for successful performance of Sanitation and Hydraulic Works Projects
Other Activities	Training of students
Web Site	http://www.univalle.edu/laboratorios/ingenieria/hidraulica.htm

Name of Institution	**Laboratorio de Hidrología (Hydrology Lab)**
Unit	Facultad de Ingeniería, Universidad del Valle (Univalle)
Location	Potosí, Department of Chuquisaca, Bolivia
Research Areas	To provide students with a broad view of the characteristics and dynamic operation of the water medium in order to train them for the detection and prevention of negative effects on natural aquatic systems, as well as for water resources assessment, planning and management

Web Site	http://www.univalle.edu/laboratorios/ingenieria/hidrologia.htm

14.2.1.3. Brazil

- Public Institutions

Name of Institution	**Facultad de Agronomía y Medicina Veterinaria (School of Agronomy and Veterinary Medicine)**
Unit	Universidad de Brasilia
Location	Brasilia DF, Brazil
Research Areas	Water-Soil-Plant-Atmosphere Relationship; Water and Soil Management and Conservation; Water and Soil Engineering: Use of Soil and Environmental Quality
Web Site	http://www.unb.br/fav/pesquisa.htm

Name of Institution	**Métodos y Modelos para Análisis Ambiental y de Recursos Hídricos (Methods and Models for Environmental and Water Resources Assessment)**
Unit	Facultad de Tecnología- Departamento de Ingeniería Civil y Ambiental, Universidad de Brasilia
Location	Brasilia DF, Brazil
Research Areas	Integration of geographic information systems and hydrological models
Web Site	http://www.unb.br/ft/enc/recursoshidricos/posrh.htm

Name of Institution	**Gestión Ambiental y de Recursos Hídricos (Environmental and Water Resources Management)**
Unit	Facultad de Tecnología- Departamento de Ingeniería Civil y Ambiental, Universidad de Brasilia
Location	Brasilia DF, Brazil
Research Areas	Development of instruments for integrated water resources management
Web Site	http://www.unb.br/ft/enc/recursoshidricos/posrh.htm

Name of Institution	**Saneamiento Ambiental (Environmental Sanitation)**
Unit	Facultad de Tecnología- Departamento de Ingeniería Civil y Ambiental, Universidad de Brasilia
Location	Brasilia DF, Brazil

Research Areas	Multi-Purpose Analysis of Technologies
Web Site	http://www.unb.br/ft/enc/recursoshidricos/posrh.htm

Name of Institution	**Hidrología Superficial y Subterránea (Surface and Groundwater Hydrology)**
Unit	Facultad de Tecnología- Departamento de Ingeniería Civil y Ambiental, Universidad de Brasilia
Location	Brasilia DF, Brazil
Research Areas	Water flow and spreading of contaminants in the subsoil
Web Site	http://www.unb.br/ft/enc/recursoshidricos/posrh.htm

Name of Institution	**Centro de Desarrollo Sustentable (Sustainable Development Centre)**
Unit	Facultad de Tecnología- Departamento de Ingeniería Civil y Ambiental, Universidad de Brasilia
Location	Brasilia DF, Brazil
Research Areas	Alternative Development Models; Public Policy and Sustainable Development; Science and Technology and Sustainable Development; Environmental Education and Sustainability
Web Site	http://www.unbcds.pro.br/cds/

Name of Institution	**Laboratorio de Energía y Ambiente (Energy and Environment Lab)**
Unit	Facultad de Tecnología, Departamento de Ingeniería Mecánica, Universidad de Brasilia
Location	Brasilia DF, Brazil
Ongoing Projects	Development of Advanced Methodologies for Water Turbine Renovation
Web Site	http://www.lea.unb.br/projetos.html

Name of Institution	**Área Ciencias Humanas (Human Sciences Area)**
Unit	Universidad Federal de Goiás
Location	Goiania, Goiás, Brazil

Ongoing Projects	Environmental Education and Sustainable Development: A Goal for the State of Goiás; Environmental Analysis of the Ribeirão Ouvidor Basin.
Web Site	http://www.prppg.ufg.br/cad_pesquisa/relatorio.php

Name of Institution	**Área Ingeniería (Engineering Area)**
Unit	Universidad Federal de Goiás
Location	Goiania, Goiás, Brazil
Ongoing Projects	Strategies for Induction Generator Control in Micro Hydropower Plants; Micro-Controlled Irrigation System: Automation and Optimisation of Power Consumption and Water Use.
Web Site	http://www.prppg.ufg.br/cad_pesquisa/relatorio.php

Name of Institution	**Área Ciencias Sociales Aplicadas (Applied Social Sciences Area)**
Unit	Universidad Federal de Goiás
Location	Goiania, Goiás, Brazil
Ongoing Projects	Water Resources Policies: An Assessment of the Paraibuna River Basin in the South of the State of Minas Gerais.
Web Site	http://www.prppg.ufg.br/cad_pesquisa/relatorio.php

Name of Institution	**Área de Ciencias Exactas y de la Tierra (Exact and Earth Sciences Area)**
Unit	Universidad Federal de Goiás
Location	Goiania, Goiás, Brazil
Ongoing Projects	Environmental Impact Assessment in the Ribeirao Ouvidor Basin, Municipality of Catalão; Geoenvironmental Characterisation of Reservoirs Using the Cross-Section Soil Loss Equation; Remote Sensor and Geoprocessing Techniques.
Web Site	http://www.prppg.ufg.br/cad_pesquisa/relatorio.php

Name of Institution	**Grupo de Conservación y Sustentabilidad del Agua en la Agricultura (Group of Water Conservation and Sustainability in Agriculture)**
Unit	Área de Ciencias Agrarias, Universidad Federal de Santa María

Location	Santa María, Rio Grande do Sul, Brazil
Research Areas	Water and soil management and conservation in agricultural systems; Technology and management of irrigation and drainage systems
Web Site	http://coralx.ufsm.br/diretorio_pesquisa/portugues

Name of Institution	**Grupo de Dinámica del Agua y de la Estructura del Suelo en Sistemas Agrícolas (Group of Water Dynamics and Soil Structure in Agricultural Systems)**
Unit	Área de Ciencias Agrarias, Universidad Federal de Santa María
Location	Santa María, Rio Grande do Sul, Brazil
Research Areas	Soil Compaction; Water availability and critical limits for plant growth and development; Water drainage and flow in basins and hydrographic microbasins; Genesis and dynamics of soil structure
Web Site	http://coralx.ufsm.br/diretorio_pesquisa/portugues

Name of Institution	**Grupo de Geomática aplicada a los recursos hídricos (Group of Geomatics Applied to Water Resources)**
Unit	Área de Ciencias Agrarias, Universidad Federal de Santa María
Location	Santa María, Rio Grande do Sul, Brazil
Research Areas	Geomatics applied to water resources; Water Resources; Hydrology applied to the management of basins; Hydrology; Basins Management
Web Site	http://coralx.ufsm.br/diretorio_pesquisa/portugues

Name of Institution	**Grupo de Manejo del Agua en Sistemas Agrícolas (Group of Water Management in Agricultural Systems)**
Unit	Área de Ciencias Agrarias, Universidad Federal de Santa María
Location	Santa María, Rio Grande do Sul, Brazil
Research Areas	Physics and Conservation of Soils and Waters; Irrigation Management and Efficient Use of Water and Energy Using Irrigation; Soil, Waters and Contaminants Management in Agricultural Systems
Web Site	http://coralx.ufsm.br/diretorio_pesquisa/portugues

Name of Institution	**Grupo de Hidrogeología (Hydrogeology Group)**

Unit	Área de Ciencias Exactas y de la Tierra, Universidad Federal de Santa María
Location	Santa María, Rio Grande do Sul, Brazil
Research Areas	Applied Geostatics; Hydrogeology
Web Site	http://coralx.ufsm.br/diretorio_pesquisa/portugues/

Name of Institution	**Departamento de Suelos e Ingeniería Rural (Department of Soils and Rural Engineering)**
Unit	Facultad de Agronomía y Medicina Veterinaria, Universidad Federal Mato Grosso
Location	Cuiabá, Mato Grosso, Brazil
Ongoing Projects	Ideal Depth of Groundwater Layer for Beans (*phaseolus vulgaris*) Irrigated Using Subirrigation Methods; Construction and Assessment of Soil Unity Determination Using Electrical Resistance Blocks
Web Site	http://www.ufmt.br

Name of Institution	**Departamento de Ciencias Veterinarias (Department of Veterinary Sciences)**
Unit	Facultad de Agronomía y Medicina Veterinaria, Universidad Federal Mato Grosso
Location	Cuiabá, Mato Grosso, Brazil
Ongoing Projects	Population Dynamics of the Stock of "peraputanga" Fish in the Cuiabá River Basin
Web Site	http://www.ufmt.br

Name of Institution	**Escuela de Arquitectura, Ingeniería y Tecnología (School of Architecture, Engineering and Technology)**
Unit	Universidad Federal de Mato Grosso
Location	Cuiabá, Mato Grosso, Brazil
Ongoing Projects	Wooden Housing Proposal for Low-Income People Along the Cuiabá River Banks; Hydrogeological Study of the Cuiabá and Várzea Grande Municipalities; Environmental Condition Survey of the Coxipó River Basin.
Web Site	http://www.ufmt.br

Name of Institution	Instituto de Biociencias (Biosciences Institute)
Unit	Universidad Federal de Mato Grosso
Location	Cuiabá, Mato Grosso, Brazil
Research Areas	Research Projects in the Biogeographic Regions of Mato Grosso: dry forests, marshland and transitional Amazon forest, prioritising flora, fauna, biodiversity and natural resources conservation issues.
Web Site	http://www.ufmt.br

Name of Institution	Instituto de Ciencias Humanas y Sociales (Institute of Human and Social Sciences)
Unit	Universidad Federal de Mato Grosso
Location	Cuiabá, Mato Grosso, Brazil
Ongoing Projects	The Basin and the Neighbourhood: An Environmental Education Experience in the Jardim Leblon Neighbourhood; A Comparative Geoenvironmental Study of the Morphostructural and Morphocultural Characteristics of Areas of the Upper Paraguay and Teles Pires Rivers Basins in the State of Mato Grosso; Relief, Tourism and Environment.
Web Site	http://www.ufmt.br

Name of Institution	Núcleo de Sistemas Hidráulicos Prediales (Nucleus of Site Hydraulic Systems)
Unit	Centro de Ciencias Exactas y Tecnología, Universidad Federal de São Carlos.
Location	São Carlos, São Paulo, Brazil
Ongoing Projects	
Web Site	http://www.deciv.ufscar.br/

Name of Institution	Área de Concentración: Desarrollo Urbano y Regional – Planeamiento y Preservación Ambiental (Focus Area: Urban and Regional Development - Environmental Planning and Preservation)
Unit	Facultad de Ingeniería Civil, Universidad Federal de Uberlândia
Location	Uberlândia, State of São Paulo, Brazil
Research Areas	Water Resources Planning, Research and Development of Basic Sanitation Processes and Methodologies; Geoenvironmental Assessment

	of Physical Environment for the Deployment of Civil Works; Recovery of Degraded Areas and Assessment of Environmental Impacts Resulting from Transportation Systems and Urban and Regional Occupation; Enhanced Development of Natural Resources and Industrial Waste in Civil Construction Works; Creation of new technologies to address civil engineering issues.
Web Site	http://www.feciv.ufu.br/pesquisas/linhasdepesquisa

Name of Institution	**Grupo de Ingeniería Agroforestal (Agroforestry Engineering Group)**
Unit	Instituto de Ciencias Agrarias, Universidad Federal de Uberlândia
Location	Uberlândia, State of São Paulo, Brazil
Research Areas	This group conducts research on irrigation and drainage, climatology, forestry and agricultural experiments
Web Site	http://www.iciag.ufu.br/nucleo_eng_agriflorestal.asp

Name of Institution	**Laboratorio de Climatología y Recursos Hídricos (Climatology and Water Resources Lab)**
Unit	Instituto de Geografía, Universidad Federal de Uberlândia
Location	Uberlândia, State of São Paulo, Brazil
Research Areas	Development of climatologic, basin monitoring, basin mapping studies; measurement of flow; soil use mapping
Services to Third Parties	Daily dissemination of weather forecasts for the region where the centre acts. Technical advisory services to the community.
Other Activities	Support to irrigation and water resources use projects. Operation of the university's meteorological instrument station and the network of meteorological spots. Teaching of undergraduate and graduate courses
Web Site	http://www.ig.ufu.br/lacrh.html

Name of Institution	**Centro de Investigación de Aguas Subterráneas (Centre for Groundwater Research)**
Unit	Instituto de Geociencias, Universidad Federal de São Paulo
Location	São Paulo, State of São Paulo, Brazil
Research Areas	Basic and Applied Hydrogeology; groundwater contamination; geochemistry of groundwaters; geophysics applied to groundwater contamination; mathematical modelling of aquifer systems and management and contamination problems; development of field data

	collection methods.
Web Site	http://www.igc.usp.br/subsites/

Name of Institution	**Instituto de Investigaciones Tecnológicas – División Geología (Technological Research Institute: Geology Division)**
Unit	Universidad Federal de São Paulo
Location	São Paulo, State of São Paulo, Brazil
Research Areas	Technological research on several areas of applied geology, particularly civil construction, mining, water resources and environment
Services to Third Parties	Specialised technical services in various areas of applied geology
Web Site	http://www.ipt.br

Name of Institution	**Grupo de investigación: Análisis Ambiental y Dinámica Territorial (Research group: Environmental Assessment and Land Dynamics)**
Unit	Instituto de Geociencias, Universidad Estadual de Campinas
Location	Campinas, State of São Paulo, Brazil
Research Areas	Major areas: exact science and earth sciences; geosciences; land dynamics; current technical systems and new social-spatial practices; geographic information systems; analysis of natural landscape components and changes resulting from use and occupation
Web Site	http://www.ige.unicamp.br/

Name of Institution	**Grupo de investigación: Transformación Tecnológica, Energía y Medio Ambiente (Research group: Technological Transformation, Energy and Environment)**
Unit	Instituto de Geociencias, Universidad Estadual de Campinas
Location	Campinas, State of São Paulo, Brazil
Research Areas	Major areas: Energy Resources Public Policies, Political Issues and Economics; Natural Resources Economics and Environment
Web Site	http://www.ige.unicamp.br/

Name of Institution	**Área de Investigación: Ambiente y Geoquímica Analítica (Research Area: Environmental and Analytical Geochemistry)**

Unit	Instituto de Geociencias, Universidad Estadual de Campinas
Location	Campinas, State of São Paulo, Brazil
Research Areas	Integrated studies on regions and basins addressing geochemical, geophysical and ecotoxicologic issues. Focused on environmental geochemistry studies in the areas of urban and rural mining, use of geographic information systems, assessment of pollution effects on human health, and application of environmental mitigation and remediation technologies. Experimental research on analytical geochemistry, including the development of analysis methods and solid, liquid and organic matrices. Use of natural resources and their effects on ecosystems and human settlements.
Web Site	http://www.ige.unicamp.br/

Name of Institution	**Área de Investigación: Política y Manejo de los Recursos Naturales (Research Area: Natural Resources Policy and Management)**
Unit	Instituto de Geociencias, Universidad Estadual de Campinas
Location	Campinas, State of São Paulo, Brazil
Research Areas	Efficient development, availability, use and conservation of mining, energy and water resources in order to prevent, control and mitigate negative impacts on society and the environment. It is based on the premise that natural resources policy and laws should encourage the transfer of benefits and their efficient use for society.
Web Site	http://www.ige.unicamp.br/

Name of Institution	**Escuela de Ingeniería Civil, Arquitectura y Planeamiento Urbano (School of Civil Engineering, Architecture and Urban Planning)**
Unit	Universidad Estadual de Campinas
Location	Campinas, State of São Paulo, Brazil
Research Areas	Hydrology and Water Resources; Hydraulic Engineering; Water Resources Support and Decision-Making System; Control and Operational Management of Hydraulic Systems
Web Site	http://www.fec.unicamp.br/ensino_pesquisa.html

Name of Institution	**Área Agua y Suelo (Water and Soil Area)**

Unit	Facultad de Ingeniería Agrícola, Universidad Estadual de Campinas
Location	Campinas, State of São Paulo, Brazil
Research Areas	Irrigation technologies; Water Resources Planning and Management
	Assessment of water treatment techniques for localised irrigation: The case of the Municipality of Paulínia-SP; Meteorological data applied to agriculture; Diagnosis of environmental and water springs conditions in basins; Water flows in agricultural cultures; Agrotoxics and nutrients impact on basin quality; Monitoring of basins.
Web Site	http://ww.agr.unicamp.br

- Private Institutions

Name of Institution	**Análisis Ambiental (Environmental Analysis)**
Unit	Área Ciencias Exactas y de la Tierra, Universidade de Guarulhos
Location	Guarulhos, State of São Paulo, Brazil
Research Areas	Landscape analysis and environmental changes indicators
Web Site	http://www.ung.br/

Name of Institution	**Bioprocesos para el Tratamiento y Uso Eficiente de Residuos y Aguas residuales (Bioprocesses for Treatment and Efficient Use of Waste and Wastewater)**
Unit	Facultad de Ingeniería, Universidad de Guarulhos
Location	São Paulo, State of São Paulo, Brazil
Research Areas	Efficient use of waste and wastewater as a fermentation substrate; efficient use of subproducts; development of bioprocesses; bioprocess simulation studies; fermentation in solid state; submerged fermentation.
Web Site	http://www.ung.br/

Name of Institution	**Grupo de Estudos e Pesquisas em Geoprocessamento para Análises Agrárias e Ambientais (GEOAGRO, Study and Research Group in Geoprocessing for Agricultural and Environmental Analyses)**
Unit	Facultad de Agronomía, Universidad do Oeste Paulista (Unoeste)
Location	Presidente Prudente, State of São Paulo, Brazil

Web Site	http://www.unoeste.br

Name of Institution	**Grupo de Estudos em Geociências (Study Group in Geosciences)**
Unit	Facultad de Ingeniería, Universidad do Oeste Paulista (Unoeste)
Location	Presidente Prudente, State of São Paulo, Brazil
Web Site	http://www.unoeste.br

Name of Institution	**Grupo de Estudos Ambientalis (Environmental Studies Group)**
Unit	Facultad de Ingeniería, Universidad do Oeste Paulista (Unoeste)
Location	Presidente Prudente, State of São Paulo, Brazil
Web Site	http://www.unoeste.br

Name of Institution	**Laboratorio de Aguas (Water Lab)**
Unit	Ciencias Biológicas, Universidad Católica de Brasilia
Location	Brasilia DF, Brazil
Research Areas	Development of new water quality analysis, sampling and monitoring techniques; Development of extension projects; Research projects related to the university's research areas.
Services to Third Parties	Consulting services to public and private sector organisations regarding regulations and standardisation. Acting as an associate in research projects.
Other Activities	Monitoring and control of water intended for human consumption; validation of the effectiveness of household liquid waste treatment; physical and chemical description of water; bacteriological analysis of water and sewage.
Web Site	http://www.ucb.br

Name of Institution	**Centro de Biología Acuática (Aquatic Biology Centre)**
Unit	Facultad de Ciencias Biológicas, Universidad Católica de Brasilia
Location	Brasilia DF, Brazil

Ongoing Projects	Structure of the Fish Community in the Lower das Mortes River, Mato Grosso do Sul; Monitoring and Management of the Ichthyofauna of Ribeirao Joao Leite; Drafting of Environmental Programmes within the Water Supply and Sanitation Programme for the City of Goiania.
Web Site	http://www.ucb.br

Name of Institution	**Grupo de Pesquisa: Agua no Meio Urbano (Research Group: Water in the Urban Environment)**
Unit	Centro de Ciencias Exactas, Ambientales y de Tecnología, Pontifícia Universidad Católica de Campinas
Location	Campinas, State of São Paulo, Brazil
Research Areas	Urban border and quality of water; Management and regulation of urban basins; Interventions in urban valleys bottoms.
Web Site	http://www.puc-campinas.edu.br/pesquisa/

Name of Institution	**Grupo de Pesquisa Gestão Ambiental Apoiada en Sistemas de Información Geográfica (Environmental Management Research Group based on Geographic Information Systems)**
Unit	Institutos de Ciencias Exactas y Tecnologías, Universidad Paulista
Location	São Paulo, State of São Paulo, Brazil
Ongoing Projects	Digital simulation (using GIS) of phenomena occurring on the surface of a basin that are detrimental to the water resource in quantitative terms (due to the reduction of the aquifer load) and in qualitative terms (due to diffuse contaminant loads that cause eutrofication). The water spring under analysis is the Jundiaí-Mirim River basin that supplies the City of Jundia. This project is carried out in association with the local sanitation service.
Web Site	http://www2.unip.br/pesquisa/grupos_pesquisa.aspx

14.2.1.4. Paraguay

- Public Institutions

Name of Institution	**Laboratorio de Limnología y Ecología Acuática (Limnology and Aquatic Ecology Lab)**
Unit	**Universidad Nacional del Pilar**
Location	Asunción, Paraguay

Research Areas	Water Quality; Aquatic Biology; General Limnology; Environmental Assessment; Aquatic Microbiology; Soil Analysis
Services to Third Parties	Training of human resources on microbiology and aquatic biology.
Ongoing Projects	Water quality control in the Hondo Stream and Paraguay River basins; Water quality control on Route IV, San Ignacio - Pilar Section.
Web Site	http://www.unp.edu.py/laboratorios/limnologia.htm

Name of Institution	**Dirección de Investigación Agrícola – DIA (Agricultural Research Board)**
Unit	Ministry of Agriculture and Cattle Raising
Location	Asunción, Paraguay
Research Areas	Development and/or identification of new biological materials and cropping, storage and conservation methods for economically-relevant plant species produced, through agricultural research and testing units. Provision of specialised lab services and seed production.
Services to Third Parties	Support and collaboration to official organisations and private-sector institutions related to the generation and transfer of technology to producers
Web Site	http://www.mag.gov.py/function.html

Name of Institution	**Dirección Nacional de Coordinación y Administración de Proyectos (DINCAP, National Board of Project Coordination and Administration)**
Unit	Ministry of Agriculture and Cattle Raising
Location	Asunción, Paraguay
Research Areas	To coordinate and manage, as applicable, the execution of Rural Development Projects with other public or private sector institutions. It was created due to the need to have a coordinating body to execute projects using foreign lending.
Ongoing Projects	Programa de Diversificación y Tecnificación Campesina (Farm Diversification and Technification Programme) (partially funded by the IDB)
Web Site	http://www.mag.gov.py/dincap/te.htm

Name of Institution	**Instituto Nacional de Tecnología y Normalización (National Institute of Technology and Standardisation)**
Unit	Department of Science and Technology

Location	Asunción, Paraguay
Research Areas	The Institute is involved in the economic and social development of Paraguay by means of scientific research, technological development and knowledge transfer to productive sectors and the community.
Web Site	http://www.intn.gov.py/Pagina_ServiciosTecnicos.htm

14.2.1.5. Uruguay

- Public Institutions

Name of Institution	**Instituto de Mecánica de los Fluidos e Ingeniería Ambiental (IMFIA, Institute of Fluid Mechanics and Environmental Engineering)**
Unit	Facultad de Ingeniería, Universidad de la República
Location	Montevideo, Uruguay
Research Areas	Research and university extension in areas related to Fluid Mechanics and Environmental Engineering
Other Activities	Courses earning credits for the Applied Fluid Mechanics graduate degree programme.
Web Site	http://www.fing.edu.uy/imfia/present/default.htm

Name of Institution	**Departamento de Suelos y Agua (Soil and Water Department)**
Unit	Facultad de Ingeniería, Universidad de la República
Location	Montevideo, Uruguay
Ongoing Projects	Irrigation Management in Citrus and Deciduous Leaf Fruit Plants (funded by Comisión Sectorial de Investigación Científica [Sector-Specific Scientific Research Commission]) Validation of Recycling and Productive Use of Dairy Farm Liquid Waste (Servicios Agropecuarios-IDB under an agreement with FUCREA)
Web Site	http://www.fagro.edu.uy/dptos/suelos/index.html

Name of Institution	**Instituto de Biología (Biology Institute)**
Unit	Department of Ecology, Facultad de Ciencias, Universidad de la República
Location	Montevideo, Uruguay

Ongoing Projects	Recovery of a Shallow Lagoon for Drinking Water Supply (developed together with IMFIA); Detection of Potentially-Toxic Phytoplankton Species in Multiple-Purpose Water Bodies (Rincón del Bonete and Palmar Reservoir, Río Negro); Water Quality in Reservoirs in the Río Negro River; Study of Eutrofication in the Salto Grande Reservoir; Study of Microalgae Toxicity in Estuary and Freshwater Environments of Uruguay; Determination of Algal Toxin Occurrence (Cyanotoxin) in Aquatic Systems and its Effects on Human Health; Front and Fishery Dynamics in the Common Fishing Area; Heavy Metal Contamination of the Montevideo Coastal Area Ichthyofauna.
Web Site	http://www.fcien.edu.uy/menu2/investigacion2.html#6

Name of Institution	**Instituto de Geología y Paleontología (Institute of Geology and Paleontology)**
Unit	Department of Ecology, Facultad de Ciencias, Universidad de la República
Location	Montevideo, Uruguay
Research Areas	Groundwater: vulnerability and protection of aquifers.
Web Site	http://www.fcien.edu.uy/menu2/investigacion2.html#6

14.2.2. Availability of master and doctorate level programmes concerning water resources

Information about master and doctorate level programmes related with water and environmental issues was organised in tables, considering:

- University
- School / Department
- Programme
- Courses (related with water and environmental issues)
- Web page

14.2.2.1. Argentina

- Public institutions

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
de Buenos Aires	Facultad de Agronomía (School of Agronomy)	Doctorate in Agronomy		http://www.agro.uba.ar/epg/programa/resumenes/resumen-dr.htm
		Master in Agronomy (orientation: Aquaculture)	Introduction to Aquaculture; Water Quality; Chemical Principles and Applications of Natural Aquatic Systems; Aquaculture Production I and II; Cold Waters Aquaculture; Warm Waters Aquaculture; Sustainable Development in Aquaculture; Assessment and Management of Continental Fisheries; Fisheries in Major Rivers; Aquatic Ecology.	http://www.agro.uba.ar/epg/programa/resumenes/resumen-ms.htm
		Master in Agronomy (orientation: Soil Sciences)	Soils Management in Sustainable Agriculture; Basin Management; Organic Contains in Soils and their Relationship with Environmental Pollution; Agricultural Wastes Management and their Environmental Impacts; Groundwater and its Uses in Complementary Irrigation; Flows and Management of Pollutants in Agro-systems.	http://www.agro.uba.ar/epg/programa/resumenes/resumen-ms.htm
		Master in Agronomy (orientation: Agricultural Production Systems in Subsistence Areas)	Basin Management; Eco-physiology of Crops; Weeds Ecology, Crops Ecology	http://www.agro.uba.ar/epg/programa/resumenes/resumen-ms.htm
de Buenos Aires	Facultad de Agronomía	Specialisation in Environmental	Agro-environmental Legislation; Water Quality in Agro-systems; Society and Environment; Natural	http://www.agro.uba.ar/epg/programa/at-descr/19.htm

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	(School of Agronomy)	Management of Agro-food Systems	Resources and the Environment Economy; Environmental Impact Assessment; Ecology; Environmental Management Systems *Optional courses*: Impacts on Agro-systems; Eco toxicology of Plaguicides; Conceptual Basis and Evolution of Environmental Management of Basins; Deteriorating Processes in Basins; Environmental Statistics.	
de Buenos Aires	Facultad de Agronomía (School of Agronomy)	Master in Agricultural and Biologic Education	Natural Resources	http://www.agro.uba.ar/epg/programa/at-descr/28.htm
		Post grade in High Direction of Rural Tourism	Rural Tourism and Environment	http://www.agro.uba.ar/epg/programa/at-descr/22.htm
	Facultad de Arquitectura y Urbanismo (School of Architecture and Urbanism)	Doctorate in Architecture	The Environmental Paradigm and the Sustainable Project; Sustainable Project in Architecture, Design and Urbanism; Ecology and Landscape; Metropolitan Ecology	http://www.fadu.uba.ar/posgrados/oferta/doc/index.html
		Master in Urban and Regional Planning	Ecology and Environment; Environmental Impact Assessment	http://www.fadu.uba.ar/posgrados/oferta/dos/pro/index.html
de Buenos Aires	Facultad de Arquitectura y Urbanismo (School of Architecture and Urbanism)	Major in Specialisation in Environmental Metropolitan Management	Methodology of Environmental Metropolitan Management; Metropolitan and Urban Environmental History; Political Ecology and Theory of Urban Sustainability; Urban and Metropolitan Ecology; Ecology of the Rural-Metropolitan Interface; Theory in Metropolitan Environmental Management; Urban and Metropolitan Environmental Legislative Frameworks; Environmental Geography of the Territory; Environmental Impact Assessment in Urban	http://www.fadu.uba.ar/posgrados/oferta/dos/gam/index.html

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
			Projects; Environmental Impact Assessment of Urban Activities; Environmental Metropolitan Management of Water; Environmental Metropolitan Management of Green Spaces; Environmental Metropolitan Management of Wastes; Integrate Metropolitan Management of Environmental and Urban Resources.	
de Buenos Aires	Facultad de Arquitectura y Urbanismo (School of Architecture and Urbanism)	Major in Specialisation in Landscape Planning	Environmental Impact; Ecology; Geography; Irrigation System; Use of Water.	http://www.fadu.uba.ar/posgrados/oferta/car/pai/index.html
		Major in Specialisation in Urban and Regional Planning	Ecology and Environment; Environmental Impact Assessment	http://www.fadu.uba.ar/posgrados/oferta/dos/pro/index.html
		Professional Actualisation Centre (Distance Course)	Environmental Impact Assessment	http://www.fadu.uba.ar/php/cap/listacursos.php?posgradoID=1
	Facultad de Ciencias Exactas y Naturales (School of Natural and Exact Sciences)	Doctorate in Atmosphere Sciences		http://www.fcen.uba.ar/posgrado/doctorad/doctorad.htm
		Doctorate in Geologic Sciences		http://www.fcen.uba.ar/posgrado/doctorad/doctorad.htm
de Buenos Aires	Facultad de Ciencias Exactas y Naturales (School of Natural and Exact Sciences)	Master in Environmental Sciences	*General Formation Cycle:* Great Natural Systems in Argentina; Intervention Processes in Natural Systems; Atmosphere; Continental Waters; Environmental Aspects in Health; Introduction to Environmental Law and Legislation; Environmental Management and Planning *Orientation in Natural Resources Cycle:* Biodiversity;	http://www.fcen.uba.ar/maestria/maes4.htm

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
			Problems and Management; Climatic Variability and Anthropogenic Impacts; Seas and Shore Areas; Environmental Chemistry; Pollution; Environmental Assessment Impact; Technology and Sustainable Development. *Technological Orientation Cycle:* Chemistry of Water and Water Contamination; Environmental Analytical Chemistry; Eco-toxicology and Environmental Toxicology; Environmental Impact Assessment; Technology and Sustainable Development.	
		Master in Agricultural Meteorology	General Meteorology; Ecology; Agricultural Meteorology; Atmospheric and Biologic Observations; Hydrology; Bio-meteorology; Environmental Animal Physiology; Agro-meteorological Models; Adverse Factors in Agriculture and Adaptations of Plants to Environmental Stress; Applied Climatology	http://www.fcen.uba.ar/maestria/maes5.htm
de Buenos Aires	Facultad de Ciencias Exactas y Naturales (School of Natural and Exact Sciences)	Major in Specialisation in Chemical and Environmental Sciences	*Module 1:* Natural Environment Chemistry; Water Chemistry and Water Pollution *Module 2:* Interactions among Pollutants, Man and the Nature; Degradation and Decontamination Mechanisms; Environmental Analytical Chemistry; Environmental Toxicology and Eco-Toxicology *Module 3:* Applied Technology to Environmental Preservation; Technology and Sustainable Development	http://www.fcen.uba.ar/especial/espe1.htm
		Major in Specialisation in Mining Geology	Mining and Environment	http://www.fcen.uba.ar/especial/espe3.htm
de Buenos Aires	Facultad de Ciencias Exactas y Naturales (School	Department of Ecology, Genetics and Evolution	*Postgraduate Courses:* Ecological Aspects to Conservation and Management of Wetlands; Pollution in Continental Waters Systems: Evolution and	http://www.ege.fcen.uba.ar/

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	of Natural and Exact Sciences)		Management; Ecology of Shore and Estuarine Systems; Water Economy in Plants and Ecosystems: Concepts, Techniques and Current Polemics; Freshwater Phytoplankton: Diversity and Ecology; Freshwater Phytoplankton Community: Diversity and Ecology	
de Buenos Aires	Facultad de Ciencias Veterinarias (School of Veterinary Sciences)	Master in Water Management	Climatic System; Hydrology; Hydrogeology; Aquatic Ecology; Water Quality; Water Resources Supply and Demand; Analysis of Water Systems; Mathematical Modelling of Transport in Water Bodies; Hydraulic Works Project; Treatment of Sewage and Industrial Effluents; Economy of Natural Resources; Legislation of Water and Environment; Applied Aspects to the Environmental Management; Integrated Water Management.	http://www.fvet.uba.ar/posgrado/maestrias/maesagua.htm
		Master in Public Health	Environment and Health	http://www.fvet.uba.ar/posgrado/maestrias/mspublica.htm
		Major in Specialisation en Harmlessness and Agro-alimentary Quality	The Environment and its Relationship with Food's Harmlessness	http://www.fvet.uba.ar/posgrado/especialid/ceica.htm
	Facultad de Derecho (School of Law)	Major in Specialisation in Natural Resources	Environmental Law; General Theory of Natural Resources; Natural Resources in Particular; Water Law; Environmental Protection.	http://www.derecho.uba.ar/academica/posgrados.php
de Buenos Aires	Facultad de Ingeniería (School of Engineering)	Major in Specialisation in Sanitation and Environmental Engineering	Environmental Sanitation and Ecology; Hydrology; Sanitation Hydraulics; Chemical and Sanitation Microbiology; Water Supply; Urban Drainage; Industrial Drainage; Biologic Contamination; Mathematical Models in Water Quality; Work Hygiene; Solid Wastes; Epidemiology: Planning and	http://www.fi.uba.ar/autoridades/secretarias/posgrado/index.php

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
			Management; Hydraulic and Sanitation Structures; Hydraulic Sanitation Operations	
de Buenos Aires	Facultad de Ingeniería (School of Engineering)	Major in Specialisation in Environmental Diagnosis and Assessment	Introduction to Ecology; Deterioration Processes of Natural Resources: Economic and Social Aspects; Environmental Legislation; Water Contamination; Industrial Wastes; Hazardous Wastes, Toxic Epidemiology; Pathologic Wastes; Radioactive Wastes; Household Wastes; Treatment of liquid effluents; Environmental Auditory	http://www.fi.uba.ar/autoridades/secretarias/posgrado/index.php
		Master in Sanitation Engineering and Environmental Sciences		http://www.fi.uba.ar/autoridades/secretarias/posgrado/index.php
		Master in Environmental Protection		http://www.fi.uba.ar/autoridades/secretarias/posgrado/index.php
		Postgraduate Courses	Integrated Water Resources Management; Maritime and Estuarine Hydraulics; Shores and Coastal Protection Design; Urban Hydraulics Planning and Management; Hydraulics and Fluvial Engineering.	http://www.fi.uba.ar/autoridades/secretarias/posgrado/index.php
Nacional de General San Martín	Ciencias de la Vida (Life Sciences)	Specialisation in Environmental Management	*Module IV*: Water Resources Management	http://www.unsam.edu.ar/oferta/carreras/ficha.asp?m=3&s=11&id=71
Nacional de General San Martín	Ciencias de la Vida (Life Sciences)	Specialisation in Assessment on Environmental Pollution and its Toxicological Risk	*Module I:*, Detection and Assessment of Pollutants; *Module IV*: Decontamination: International Regulation Norms	http://www.unsam.edu.ar/oferta/carreras/ficha.asp?m=3&s=11&id=55

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
Nacional de General San Martín	Ciencias Exactas, Ingeniería y Tecnología (Exact Sciences, Engineering and Technology)	Specialisation in Industrial Quality (with the INTI)	*Optional Activities:* Intensive Course of Environmental Management Systems – ISO 14000	http://www.inti.gov.ar/capacitacion/calidad/industrial.htm
	Ciencias Exactas, Ingeniería y Tecnología (Exact Sciences, Engineering and Technology)	Specialisation in Food Quality (with INTI):	*Optional Activities:* Intensive Course of Environmental Management Systems – ISO 14000; Environmental Quality Auditory	http://www.inti.gov.ar/capacitacion/calidad/alimentos.htm
	Ciencias de la Vida (Life Sciences)	Master in Plagues Control and its Environmental Impact	Eco-toxicology of Plagues Control; Contamination of watercourses; Specific Problems of Water Pollution: BOD, COD, Toxic Compounds, Heat, pH, Suspended Solids, Eutrophication; Drinking Water Concept.	http://www.unsam.edu.ar/oferta/carreras/ficha.asp?m=3&s=11&id=78
	Ciencias de la Vida (Life Sciences)	Master in Environmental Management	Water Resources Management; Industrial Wastes Management	http://www.unsam.edu.ar/oferta/carreras/ficha.asp?m=3&s=11&id=68
Nacional de General Sarmiento	---	Major in Specialisation in Local Development in Urban Regions	Environment and City Production	http://www.ungs.edu.ar/ungs/posgrados.htm
Nacional de La Matanza	---	Master in Environmental Management		http://www.unlm.edu.ar/index.php?pageid=313&idioma=esp
Nacional de La Plata	Facultad de Arquitectura y Urbanismo (School of	Master in Landscape, Environment and the City		http://www.fau.unlp.edu.ar/posgrado/posgrado-carrera-grado.htm

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Architecture and Urbanism)			
Nacional de La Plata	Facultad de Ciencias Agrarias y Forestales (School of Agricultural and Forest Sciences)	Doctorate of School of Agricultural and Forest Sciences		http://www.agro.unlp.edu.ar/institucional/secretarias/posgrado/posgrado-index.html
		Master in Vegetal Protection		http://www.agro.unlp.edu.ar/institucional/secretarias/posgrado/posgrado-index.html
		Master in Drainage Basin Management	Management of Drainage Basins; Hydrology of Plains; Mathematical Modelling of Environmental Management and Drainage Basins; Agro-ecology	http://www.agro.unlp.edu.ar/institucional/secretarias/posgrado/carreras/cuencas/index.html
		Major in Specialisation in Landscape Planning and Environment	Ecology and Gardens; Supplementary Irrigation	http://www.agro.unlp.edu.ar/institucional/secretarias/posgrado/posgrado-index.html
	Facultad de Ciencias Exactas (School of Exact Sciences)	Master in Technology and Hygiene of Food		http://www.exactas.unlp.edu.ar/secretarias/maestria2.htm
	Facultad de Ingeniería (School of Engineering)	Master and Doctorate in Engineering		http://www.ing.unlp.edu.ar/decanato/epec/index.php?pag=Doctorado%20en%20Ingenieria
Nacional de La Plata	Facultad de Ingeniería (School of Engineering) and Facultad de Ciencias Naturales	Master in Ecohydrology	Introduction to Hydro-meteorology; Ecology of Continental Aquatic Environments; Bases of Surface Hydrology; Bases of Groundwater Hydrology; Environmental Chemistry; Advanced Surface Hydrology; Environmental Geo-hydrology; Methods and Techniques in Environmental Diagnosis and	http://www.ing.unlp.edu.ar/decanato/epec/index.php?pag=Maestria%20en%20Ecohidrologia

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	y Museo (School of Natural Sciences and Museum)		Management.	
Nacional de La Plata	Facultad de Ingeniería (School of Engineering)	Master in Road Engineering	Road Works Drainages; Assessment on Active Bridges	http://www.ing.unlp.edu.ar/decanato/epec/carreras/vial/paginas/introduccion.htm
		Specialisation in Applied Hydraulics		http://www.unlp.edu.ar/index.php?pagina=posgrado.htm&camino=POSGRADO
Nacional de Lanús	---	Master in Food Technology	Food Industry and Environment	http://www.unla.edu.ar/maestrias/alimentos/alimentos.php
	---	Master in Sustainable Development		http://www.unla.edu.ar/index1.php
Nacional de Luján	---	Major in Specialisation: Remote Sensing and Geographical Information Systems applied to Environmental Studies	Environmental Knowledge and Management; Territorial Planning; Physical Planning and Environmental Impact of Works; Natural Resources Management; Natural Risks Assessment; Protection of Natural Resources	http://www.unlu.edu.ar/~telsig/
Nacional del Centro de la Provincia de Buenos Aires	Facultad de Agronomía (School of Agronomy)	Master in Remote Sensing and Geographical Information Systems	Ecosystem Dynamics and Remote Sensing	http://www.unicen.edu.ar/a/carreras/posgradopordisciplina.htm
Nacional del Litoral	Facultad de Arquitectura,	Specialisation in Environmental		http://www.fadu.unl.edu.ar

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Diseño y Urbanismo (School of Architecture, Design and Urbanism)	Planning		
	Facultad de Bioquímica y Ciencias Biológicas (School of Biochemistry and Biological Sciences)	Master in Environmental Health	Environmental Toxicology and Principles on Eco-toxicology; Environmental Physic-pathology; Environmental Education and Communication in Health; Environmental Impact Assessment and Risks Management in Environmental Health; Environment and Health II: Water and Sanitation; Ethics, Policy and Legislation in Environmental Health.	http://www.fbcb.unl.edu.ar
Nacional del Litoral	Facultad de Ciencias Agrícolas (School of Agricultural Sciences)	Specialisation in Agricultural Land Irrigation	Environmental and Agrarian Legislation; Elements of Applied Hydraulics; General Hydrology; Rural Extension in Irrigation Projects; Groundwater Prospecting and Assessment; Drainage; Water and Crops Production; Uses of Groundwater; Bases of Irrigation; Surface Irrigation; Sprinkling Irrigation; Operation and Conservation of Irrigation Systems; Formulation and Analysis of Investment Project on Irrigation; Environmental Management of Irrigation Projects; Special Applications of Irrigation; Simulation Models Applied to Irrigation	http://www.fca.unl.edu.ar

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Facultad de Ingeniería y Ciencias Hídricas (School of Engineering and Water Sciences)	Specialisation in Environmental Management	Social and Environmental Sciences; Environmental Law; Environmental Economy; Sociology, Territory and Environment; Environmental Policy and Ethics; Ecology and Environmental Pathologies; Populations Ecology; Communities and Systems Ecology; Environmental and Health; Environmental Pathologies; Environmental Planning; Environmental Impact Assessment; Environmental Management Systems	http://www.fich.unl.edu.ar
	Facultad de Ingeniería y Ciencias Hídricas (School of Engineering and Water Sciences)	Specialisation in Irrigation on Agricultural Lands	Elements of Applied Hydraulics; Groundwater Assessment and Uses; Agronomy of Irrigation; Bases of Irrigation; Agricultural Drainage; Surface Irrigation; Aspersion Irrigation; Localised Irrigation; Economic and Environmental Assessment of Irrigation Projects; Irrigation Systems Operation and Conservation.	http://www.fich.unl.edu.ar
Nacional del Litoral	Facultad de Ingeniería y Ciencias Hídricas (School of Engineering and Water Sciences)	Master in Water Resources Engineering	Bases of Hydrology; Hydrological Analysis I, II and III; Atmospheric Water; Surface Water; Groundwater; Hydrological Simulation; Urban Drainage; Hydrological Statistics; Aquifer Systems Hydrodynamics; Variability and Climate Change; Bases of Hydraulics; Fluvial Hydraulics, Erosive Processes in Bridges; Pumps and Pump Stations; Fluvial Engineering; Stability in Alluvial Riverbeds; Hydrological Design; Water Resources Planning and Management; Groundwater Resources Management and Protection; Environmental Chemistry; Transport of Pollutants; Environmental Modelling; Natural Tracers in Hydro-environmental Problems; Environmental Isotopes in Hydrology.	http://www.fich.unl.edu.ar

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
		Master in Environmental Management	Idem Specialisation in Environmental Management	http://www.fich.unl.edu.ar
Nacional de Rosario	Facultad de Ciencias Exactas, Ingeniería y Agrimensura (School of Exact Sciences, Engineering and Surveying)	Doctorate in Engineering with mention in Hydraulics and in Sanitation and Environment		http://www.fceia.unr.edu.ar/posgrado/
Nacional de Rosario	Facultad de Ciencias Exactas, Ingeniería y Agrimensura (School of Exact Sciences, Engineering and Surveying)	Master in Water Resources in Plain Areas	Geomorphology and Fluvial Hydraulics; Flows in Free Surface Mathematical Hydro-dynamical Modelling; Hydrological Systems Analysis; Advanced Fluid Mechanics; Hydro-environmental Planning; Hydrology in Anthropic Environments; Hydrology of Aquifers in Sedimentary Rocks; Water Erosion in Cohesive Riverbeds; Stochastic Mathematical Modelling to Simulation and Forecast of Hydrological Processes.	http://www.fceia.unr.edu.ar/posgrado/
		Doctorate in Engineering (Mention: Hydraulics)	Hydrological Mathematical Modelling of Free Surface Flows; Analysis of Atypical Hydrological Systems; Advanced Fluid Mechanics; Geomorphology and Fluvial Hydraulics; Hydro environmental Planning; Pollutants Transport in Water Bodies; Urban Hydrology; Water Erosion Processes; Mathematical Modelling to Forecast Hydrological Processes; Groundwater Hydrology.	http://www.fceia.unr.edu.ar/posgrado/

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
		Doctorate in Engineering (Mention: Sanitation and Environmental)	Unitary Processes of Water Purification; Unitary Processes of Industrial Wastes Treatment; Water Pollution; Sewage Systems; Solid Wastes.	http://www.fceia.unr.edu.ar/posgrado/
		Doctorate in Engineering (Mention: Roads and Transport)	Project , Construction and Conservation in Sewers; Conservation.	http://www.fceia.unr.edu.ar/posgrado/
Nacional de Rosario	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Master in Management and Conservation of Natural Resources		http://www.fcagr.unr.edu.ar/Docencia/escgraduados/cursos/maestrias/mtrrecnaturales.htm
	Facultad de Ciencia Política y Relaciones Internacionales (School of Political Science and International Relationships)	Specialisation in Environmental Communication		http://www.fcpolit.unr.edu.ar/
	Facultad de Arquitectura, Planeamiento y Diseño (School of Architecture, Planning and Design)	Major in Specialisation in Urban-Territorial Planning	Environmental Aspects of Spatial Planning	http://www.fapyd.unr.edu.ar/postgrado/index.htm

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Centro de Estudios Interdisciplinarios (Interdisciplinary Studies Centre)	Master in Human Environmental Systems		http://www.unr.edu.ar/academica/cei/_cei-maestria-sis-amb-humanos.htm
Nacional del Nordeste	Facultad de Ingeniería (School of Engineering)	---	Postgraduate Course in Urban Hydrology	http://ing.unne.edu.ar/
	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Doctorate in Natural Resources		http://agr.unne.edu.ar/p/doctorado.htm
	Facultad de Ciencias Exactas y Naturales y Agrimensura (School of Exact and Natural Sciences and Surveying)	Master in Non Renewable Energies	Environmental Problems; Micro Turbines; Power Generation through Pumping.	http://exa.unne.edu.ar/
	Facultad de Arquitectura y Urbanismo (School of Architecture and Urbanism)	Master in Environmental Management, Landscape and Heritage		http://arq.unne.edu.ar/
		Master in Environmental Management		http://arq.unne.edu.ar/
		---	Postgraduate Course in Urban Management and Sustainable Development	http://arq.unne.edu.ar/

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
Nacional de Misiones	Facultad de Ciencias Forestales (School of Forest Sciences)	Master in Forest Sciences	Ecological Bases to Forestry; Forest Eco-physiology.	http://www.facfor.unam.edu.ar/
Nacional de Río Cuarto	Facultad de Ciencias Exactas, Físico- Químicas y Naturales (School of Exact, Physics-Chemical and Natural Sciences)	Specialisation in Environmental Geology		http://intra.exa.unrc.edu.ar/posgrado/carrerap osg.html
Nacional de Córdoba	Facultad de Ciencias Exactas, Físicas y Naturales (School of Exact, Physical and Natural Sciences)	Doctorate in Engineering Sciences	Courses are selected by the student according to the specialisation and the advising of the Advisory Commission.	http://www.efn.unc.edu.ar/postgrado_cs_ing. html
Nacional de Córdoba	Facultad de Ciencias Exactas, Físicas y Naturales (School of Exact, Physical and Natural Sciences)	Master in Engineering Sciences, Mention in Water Resources	Groundwater Hydrology; Advanced Hydrology; Advanced Free Surface Flows; Advanced Fluid Mechanics; Environmental Hydraulics I. *Optional:* Hydrology and Stochastic Processes; Mechanics of Sediments Transport; Fluvial Hydraulics; Hydraulics of Small and Large Works; Urban Hydrology and Basin Management; Turbulence; Research in Operations I; Research in Operations II; Design Rains; Apply of Remote Sensing to Water Resources.	http://www.efn.unc.edu.ar/postgrado_RRHH .html

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
		Master Programme in Wildlife Management	General Ecology; Conservation Problems in Latin America; Environmental Education and Extension; Economy of Natural Resources; Environmental Impact (optional).	http://www.efn.uncor.edu/esc/mmvs/index.htm
	Facultad de Ciencias Agropecuarias (School of Agricultural and Livestock Sciences)	Master in Agricultural and Livestock Sciences, mention in Environmental Management	Sustainability of Environmental Systems; Environmental Impact Asssessment; Economy of Natural Resources; Environmental Law and Legislation; Basin Management under Water Erosion; Torrent Control.	http://vaca.agro.uncor.edu/~posgrado/maestria/master_agro/Index.htm
		Master in Agricultural and Livestock Sciences, mention in Natural Resources	Personalised curricula	http://vaca.agro.uncor.edu/~posgrado/index.htm
Nacional de Córdoba		Master in Agricultural and Livestock Sciences, mention in Agro-meteorology	Hydro-meteorology; Agro-meteorology I; Agro-meteorology II; Agro-meteorology III.	http://vaca.agro.uncor.edu/~posgrado/index.htm
Nacional de Córdoba	Facultad de Arquitectura, Diseño y Urbanismo (School of Architecture, Design and Urbanism)	Master in Environmental Management of Urban Development	Theory and Methodology in Environmental Management of Urban Development; Ecological Bases of Urban Environmental Management; Environmental History; Urban and Regional Environmental Economics; Environmental Law and Legislation; Environmental Theory of Territory; Integrated Management of Natural Resources at Regional and Urban Levels; Environmental Planning and Management; Environment and Infrastructure;	http://www.faudi.unc.edu.ar/areas/academica/posgrado.htm

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
			Environmental Impact of Development; Environmental Information Systems; Environmental Technologies and Management.	
Nacional de Tucumán	Facultad de Ciencias Exactas y Tecnología (School of Exact Sciences and Technology)	Master in Structural Engineering and Doctorate in Engineering	Doctorate oriented to Structural Engineering	http://www.herrera.unt.edu.ar/facet/academico/posgrado.asp
	Facultad de Ciencias Naturales e Instituto Miguel Lillo (School of Natural Sciences and Miguel Lillo Institute)	Doctorate in Biological Sciences		http://www.csnat.unt.edu.ar/postgrado/posgrado.htm
		Doctorate in Geology		http://www.csnat.unt.edu.ar/postgrado/posgrado.htm
Nacional de Tucumán	Facultad de Bioquímica, Química y Farmacia (School of Biochemistry, Chemistry and Pharmacy)	Doctorate and Master in Chemical Sciences	Hydro-geochemistry of Natural Systems; Chemistry of Environment	http://www.unt.edu.ar/facbioq/academico.htm
Tecnológica Nacional	Facultad Regional Buenos Aires (Buenos Aires Regional School)	Master in Environmental Engineering	Introduction to the Environmental Problems; Applied Ecology and Natural Resources; Environmental Norms and Ethics Bases; Environmental Chemistry; Pollutants Transport in Aquatic Environments; Management of Liquid Effluents; Environmental Impacts and Risks; Environmental Sociology; Environmental Economy.	http://academica.frba.utn.edu.ar/postgr/

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
		Specialisation in Environmental Engineering	Courses are the same as the Master in Environmental Engineering. The Specialisation do not have a Master Thesis.	http://academica.frba.utn.edu.ar/postgr/
	Facultad Regional General Pacheco (General Pacheco Regional School)	Master in Environmental Engineering	Introduction to the Environmental Problems; Applied Ecology and Natural Resources; Environmental Norms and Ethics Bases; Environmental Chemistry; Pollutants Transport in Aquatic Environments; Management of Liquid Effluents; Environmental Impacts and Risks; Environmental Sociology; Environmental Economy.	http://www.frgp.utn.edu.ar/maepos/2.php
		Specialisation in Environmental Engineering	Courses are the same as the Master in Environmental Engineering. The Specialisation do not have a Master Thesis.	http://www.frgp.utn.edu.ar/maepos/2.php
Tecnológica Nacional	Facultad Regional Delta	Specialisation in Environmental Engineering	Introduction to the Environmental Problems; Applied Ecology and Natural Resources; Environmental Norms and Ethics Bases; Environmental Chemistry; Applied Hydraulics; Applied Meteorology; Management of Liquid Effluents; Environmental Impact and Risk; Environmental Sociology and Policy; Environmental Economy.	http://www.frd.utn.edu.ar/?opc=IngenieriaAmbiental
Tecnológica Nacional	Facultad Regional Rosario (Rosario Regional School)	Master in Environmental Engineering	Introduction to the Environmental Problems; Applied Ecology and Natural Resources; Environmental Norms and Ethics Bases; Environmental Chemistry; Pollutants Transport in Aquatic Environments; Management of Liquid Effluents; Environmental Impact Assessment; Environmental Economy.	http://www.frro.utn.edu.ar/new/postgrado/post_carreras_maestrias_ia.php
		Specialisation in Environmental Engineering	Courses are the same as the Master in Environmental Engineering. The Specialisation do not have a Master Thesis.	

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Facultad Regional Santa Fe (Santa Fe Regional School)	Doctorate in Engineering (mention: Civil Engineering)		http://170.210.78.2/estudios_y_acceso/posgrado/doctorado/index.htm
		Master in Environmental Engineering	Introduction to the Environmental Problems; Applied Ecology and Natural Resources; Environmental Law and Ethics Bases; Environmental Chemistry; Pollutants Transport in Aquatic Environments; Management of Liquid Effluents; Environmental Impact and Risk; Environmental Sociology and Policy; Environmental Economy.	http://www.frsf.utn.edu.ar/matero/visita_carrera/index.php?idp=4
		Specialisation in Environmental Engineering	Courses are the same as the Master in Environmental Engineering. The Specialisation do not have a Master Thesis.	
Tecnológica Nacional	Facultad Regional Concepción del Uruguay (Concepción del Uruguay Regional School)	Master in Environmental Engineering	Introduction to the Environmental Problems; Applied Ecology and Natural Resources; Environmental Law and Ethics Bases; Environmental Chemistry; Pollutants Transport in Aquatic Environments; Management of Liquid Effluents; Environmental Impact and Risk; Environmental Sociology and Policy; Environmental Economy.	http://www.frcu.utn.edu.ar/posgrado/mia/maestria_ambiental.html?lang=1&id_carrera=2&id_depto=5&id_area=2
Tecnológica Nacional	Unidad Académica Concordia (Concordia Academic Unit)	Specialisation in Environmental Engineering	Introduction to the Environmental Problems; Applied Ecology and Natural Resources; Environmental Law and Ethics Bases; Environmental Chemistry; Pollutants Transport in Aquatic Environments; Management of Liquid Effluents; Environmental Impact and Risk; Environmental Sociology and Policy; Environmental Economy.	http://www.uac.utn.edu.ar/ing_ambiental.php

- Private institutions

University	School / Department	Postgraduate Career	Courses (related to water and environmental issues)	Web site
Pontificia Universidad Católica Argentina	Facultad de Ingeniería (School of Engineering)	Specialisation in Safety, Hygiene and Environmental Protection	Environmental Law; Safety Management; Environmental Hygiene and Protection; Hygiene and Environmental Protection; Water Pollution Assessment and Treatment; Applied Ecology.	http://www2.uca.edu.ar/esp/sec-fingenieria/esp/page.php?subsec=posgrado&page=carreras
	Facultad de Derecho, sede Buenos Aires (School of Law, Buenos Aires)	Specialisation in Environmental Law	Introduction to the Environmental Problems and Law; Environmental Management and Policy; Responsibility for Environmental Damage; Legal Regime for Continental Waters Protection; Environmental Legal Regime for Industrial and Tertiary Activities	http://www2.uca.edu.ar/esp/sec-fderecho/esp/page.php?subsec=posgrado&page=especializaciones
		Specialisation in High Technology Law	Environmental Law.	http://www2.uca.edu.ar/esp/sec-fderecho/esp/page.php?subsec=posgrado&page=especializaciones
	Facultad Católica de Química e Ingeniería Fray Rogelio Bacon (Catholic School of Chemistry and Engineering Fray Rogelio Bacon)	Master in Environmental Engineering and Sustainable Development	Introduction to Ecology and Environmental Problems; Environmental Law and Policy; Environmental Chemistry; Environmental Microbiology; Eco-toxicology; Management of Liquid Effluents; Environmental Assessment; Environmental Management Systems; Environmental Information Systems and Modelling; Sustainable Development and Companies; Environmental Sociology and Education; Environmental Economy.	http://www.bacon.org.ar/maestriaambiental.php
Católica de Salta	Escuela de Negocios (Business School)	Master in Environmental Management	Introduction to Environmental Problems; Environmental Economy; Environmental Policy and Legislation; Environmental Pollution; Environmental Research; Environmental Management and Organisation of Territories; Environmental Urban Planning; Environmental Auditory and Safety and Hygiene; Environmental Impact Assessment;	http://www.eneg.ucasal.net/NewWebsite/Carreras/maestriagestamb.htm

University	School / Department	Postgraduate Career	Courses (related to water and environmental issues)	Web site
			Economic Evaluation of Environmental Damage; Environment and Sustainable Development; Formulation and Assessment of Environmental Projects; Environmental Management and Strategic Planning	
Católica de Santa Fe	---	Master in Impact Assessment and Environmental Management	Introduction to Ecology and Environment; Natural Systems; Environmental Economy; Environmental Law and Policy and Communication; National and International Environmental Problems; Environmental Inventory; Pollution; Environmental Information Systems and Modelling; Environmental Risks; Environmental Impact Assessment; Management Systems and Environmental Auditory; Environmental Management; Environmental Ethics and Professional Mission.	http://www.ucsf.edu.ar/posgrado/maestrias/page1.htm
Universidad de Morón	Facultad de Arquitectura, Diseño, Arte y Urbanismo (School of Architecture, Design, Art and Urbanism)	Master in Landscape Planning and Management	Geography and Landscape Ecology; Environmental Impact; Natural Reserves.	http://www.unimoron.edu.ar
Universidad del Salvador (USAL)	Facultad de Ciencias Jurídicas (School of Law Sciences)	Specialisation in Environmental Law and Economy	Nature, Culture and Law; Environmental Law System; Environmental Management and Organisation; Environmental Amends; Legal Protection to the Environment; Technology and Environmental Economic Instruments; Macro-economy and Environment; Environmental Administration; Biotechnology, Economy and Environment; Environment, Integration and Services.	http://www.salvador.edu.ar

University	School / Department	Postgraduate Career	Courses (related to water and environmental issues)	Web site
Universidad de Concepción del Uruguay	Facultad de Ciencias Agrarias (School of Agrarian Sciences)	Master in Organisation and Sustainable Management of Zootechnic Production and Environmental Tutelage	Soil Fertility and Techniques of Low Environmental Impact.	http://www.ucu.edu.ar
Universidad de Ciencias Empresariales y Sociales	---	Master in Environmental Studies	Global Environmental Contemporany Processes; Critic Problems of Environment; Natural Sciences and Ecology; Applied Environmental Sciences; Company and Environmental Policy; Energy and Environment; Environmental Ethics; Methods in Environmental Studies; Sustainable Development; Environmental Studies Paradigms; Environmental Law; Bases of Nature, Technology and Society Relationships; Environmental Impact Assessment.	http://www.uces.edu.ar/masters/master_est_amb.php

14.2.2.2. Bolivia

- Public institutions

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
Autónoma Juan Misael Saracho	---	Master in Applied Hydraulics Engineering	Mentions in Environmental Sanitation Management; Water Resources Management; Irrigation and Drainage.	http://www.uajms.edu.bo/unidades/posgrado/posgrado.html

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	---	Master in Agricultural and Livestock Sciences	Mention in Irrigation and Drainage.	http://www.uajms.edu.bo/unidades/posgrado/msscagr/index.htm
	---	Master in River Basins Management		http://www.uajms.edu.bo/unidades/posgrado/posgrado.html
	---	Doctorate in Formation and Research in Environment		http://www.uajms.edu.bo/unidades/posgrado/posgrado.html
Autónoma Gabriel René Moreno	Área de Ciencias Agrícolas y Pecuarias (Area of Agriculture and Livestock Sciences)	Master in Agricultural and Livestock and Sustainable Agriculture		http://www.uagrm.edu.bo/pgrado/index_postgrado.php?postfac=&fac=
	Área Ambiental (Environmental Area)	Master in Environmental Pollution Prevention and Control		http://www.uagrm.edu.bo/pgrado/index_postgrado.php?postfac=&fac=
Autónoma Gabriel René Moreno	Área Ambiental (Environmental Area)	Specialisation in Environmental Pollution Prevention and Control		http://www.uagrm.edu.bo/pgrado/index_postgrado.php?postfac=&fac=
Autónoma Gabriel René Moreno	Área Ambiental (Environmental Area)	Diploma in Wastewater Management		http://www.uagrm.edu.bo/pgrado/index_postgrado.php?postfac=&fac=

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Facultad de Veterinaria y Zootecnia (School of Veterinary and Zootechnique)	Diploma in Livestock and Environment in Local Development		http://www.uagrm.edu.bo/pgrado/index_postgrado.php?postfac=&fac=
Real Mayor y Pontificia San Francisco Xavier de Chuquisaca	----	International Master in Water Resources	Basic and General Hydrology; Advanced and Applied Hydrology; River Hydraulics; Hydro-systems Modelling; Water Quality Modelling; Geographical Information Systems; Hydraulic Resources Planning and Control; Integrated Systems of Urban Drainage; Domestic Wastewaters Treatment; Hydraulic Works I; Hydraulic Works II	http://posgrado.usfx.edu.bo/programas.php?op=ve&tipo=ma&titulo=Maestrías&prog=mirh
Autónoma Tomás Frías	---	Master in Environment		http://www.uatf.edu.bo/
	---	Master in Agriculture and Livestock Sciences		http://www.uatf.edu.bo/

- Private Institutions

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
Nur de Bolivia	---	Master in Sustainable Development	Diplomas: Introduction to Sustainable Development; Environment and Development; Socio-economic Development	http://www.nur.edu/52626/wp_m00c0.asp

14.2.2.3. Brazil

- Public Institutions

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
Federal de Brasilia	Facultad de Tecnología (School of Technology)	Master and Doctorate in Environmental Technology and Water Resources	Applied Hydraulics; Applied Hydrology; Introduction to Environmental Management; Water Quality; Environmental Analysis Techniques; Water Supply; Analysis of Environmental Systems I and II; Air Pollution Control; Water Pollution Control; Teaching in Environmental Technology and Water Resources; Remote Sensing applied to Environmental Management; Groundwater Hydrology; Numeric Methods in Water Resources; Sanitation Systems Planning; Hydrological Simulation; Topics in Environmental Management; Topics in Water Resources; Topics in Sanitation; Water Treatment; Wastewater Treatment.	http://www.r/ft/enc/recursoshidricos/posrh.htm
	Instituto de Ciencias Humanas (Department of Human Sciences)	Master in Geography (mention in Environmental Management and Territory Management)	Urbanisation and Environment; River Basins Management; Environmental Impact Assessment; Impact of Energy Sources Uses.	http://www.unb.br/ih/gea/
	Facultad de Arquitectura y Urbanismo (School of Architecture and Urbanism	Master and Doctorate in Architecture and Urbanism	Urban Environmental and Architectonic Control; Space and Environment; Methodology of Environmental Planning.	http://www.unb.br/fau/pos_graduacao

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Instituto de Geociencias (Department of Geosciences)	Master and Doctorate in Geology	Applied Hydrogeology	http://www.unb.br/ig/posg/
Federal de Brasilia	Facultad de Agronomía y Medicina Veterinaria (School of Agronomy and Veterinary Medicine)	Master in Agrarian Sciences	Mention in Management of Soils and Water.	http://www.unb.br/fav/posgradu.htm
	Centro de Desarrollo Sustentable (Centre of Sustainable Development)	Master in Sustainable Development, Environmental Policy and Management	Bases of Environmental Sciences; Environmental Management; Public Policies and Environment; Environmental Economy; Environmental Law; Agriculture and Environment; Anthropology of Development and Environment; Environmental Auditory; Environmental Impact Assessment; Environmental Decision; Environmental Education; Political Geography and Environment; Management of Water Resources; Economic Instruments and Environment; Environment and International Trade; Mining and Environment; Environmental Planning; Global Environmental Policy and Sustainable Development; Environmental Policy and Organised Civil Society; Special Topics on Sustainable Development; Special Topics in Urban Environment and Social Exclusion.	http://www.unbcds.pro.br/cds/exec/index.cfm

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
		Master in Sustainable Development, Environmental Policy and Management	Environmental Management; Environmental Socio-economy; Agriculture and Environment; Anthropology of Development and Environment; Environmental Auditory; Environmental Impacts Assessment; Environmental Education; Political Geography and Environment; Management of Water Resources; Economic Instruments and Environment; Environment and International Trade; Mining and Environment; Global Environmental Policy and Sustainable Development; Environmental Policy and Organised Civil Society; Special Topics on Sustainable Development; Special Topics on Urban Environment and Social Exclusion.	http://www.unbcds.pro.br/cds/exec/index.cfm
Federal de Goias	Escuela de Ingeniería Civil (School of Civil Engineering)	Master in Civil Engineering	Hydraulic and Sanitation Lots Systems	http://www.prppg.ufg.br/pos_graduacao/mestrado_ecivil.php http://www.eec.ufg.br/cursos.htm
		Master in Engineering of the Environment	Water Quality; Chemistry Applied to Engineering of Environment; Hydrobiology Applied to Engineering of Environment; Water Treatment for Supply; Filtration Technologies for Water Treatment for Supply; Wastewaters Treatment; Analysis and Exam of Water and Wastewater; Water Resources Engineering; Management of Water Resources; Modelling of Surface Waters Quality; Modelling of Urban Drainage Systems; Hydro-informatics; Hydrological Models; Channel Hydraulics; Hydraulic and Sanitation Lot Systems; Special Topics in Environmental Engineering.	http://www.prppg.ufg.br/pos_graduacao/mestrado_emambiente.php http://www.eec.ufg.br/cursos.htm

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Escuela de Agronomía y de Ingeniería Ambiental (School of Agronomy and Environmental Engineering)	Master and Doctorate in Agronomy (Mention: Soils and Water)	Applied Hydrology; Water-Soil-Plant-Atmosphere Relation; Irrigation in Agricultural Production; Irrigation and Drainage Systems in Agricultural Production; Integrated River Basin Management.	http://www.prppg.ufg.br/pos_graduacao/mestrado_agronomia.php http://www.prppg.ufg.br/pos_graduacao/doutorado_agronomia.php http://www.agro.ufg.br/pos_graduacao.htm
	Instituto de Estudios Socio ambientales (Institute of Socio-environmental Studies)	Master in Geography	Environmental Analysis of River Basins; Drainage Morphology in Cerrado Domain; Environmental Planning; Topics in Environmental Education; Water Resources and Environment.	http://www.prppg.ufg.br/pos_graduacao/mestrado_geografia.php http://www.iesa.ufg.br
Federal de Goias	---	Doctorate in Environmental Studies	Introduction to Environmental Science; Offices in Environmental Analysis; Water Resources Monitoring and Conservation; Topics in Environmental Sciences; Environmental Planning; Environmental Education; Frontiers and Environment; Soils and Environment; Environmental Law and Legislation.	http://www.prppg.ufg.br/pos_graduacao/doutorado_ambientais.php
Federal de Santa Maria	Centro de Ciencias Rurales (Centre of Rural Sciences)	Master in Agricultural Engineering	Agricultural Hydraulic Structures; Water Resources Management; Applied Hydrology; Localised Irrigation; Surface Irrigation; Soil-Water-Plant Relationship.	http://portal.ufsm.br/ementario/cursos
		Doctorate in Agricultural Engineering	Drainage in Agricultural Lands; Agricultural Hydraulic Structures; Applied Hydrology; Localised Irrigation; Surface Irrigation; Modelling of Water Flow in Soils; Soil-Water-Plant Relationship; Water Resources Management.	http://portal.ufsm.br/ementario/cursos

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Centro de Tecnología (Centre of Technology)	Master in Civil Engineering	Hydro-energy of Small Basins; Hydroelectric Works; Remote Sensing Applied to Water Resources; Qualitative Aspects of Water Resources; Quantitative Aspects of Water Resources; Complements of Hydraulics; Urban Drainage and Hydrology; Water Resources Management I and II; Hydrological Modelling; Quantitative Modelling of Water Resources; Special Topics in Water Resources; Elements of Hydrology; Elements of Hydraulics.	http://portal.ufsm.br/ementario/cursos
	Centro de Ciencias Naturales y Exactas-Departamento de Geociencias (Centre of Natural Sciences, Department of Geosciences)	Master in Geography	Geomorphology Applied to Environmental Planning and Management; Groundwater Resources Management; Processes of Superficial Dynamics and Associated Environmental Risks; Rational Use of Water Resources and Sustainable Development.	http://portal.ufsm.br/ementario/cursos
Federal de Mato Grosso	Instituto de Biociencias (Institute of Biosciences)	Master in Ecology and Biodiversity Conservation	Biology of Conservation; Ecology of Field; Ecology of Ecosystems and Communities; Ecology of Populations; Ecology of Flooding Areas; Fishing: Legislation, Policy and Culture; Ecological Processes; Bio-indicators and Environmental Monitoring.	http://www.ufmt.br
Federal de Mato Grosso	Instituto de Ciencias Humanas y Sociales (Institute of Human and Social Sciences)	Master in Environment and Regional Development		http://www.ufmt.br

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
Federal de Mato Grosso do Sul	---	Master in Agribusiness (oriented to Sustainable Development)	Regional Development and Socio-Environmental Impacts of Agribusiness; Agribusiness and Environment	http://www.ufms.br
		Master in Ecology and Conservation	Ecology of Freshwater Fishes; Ecology of Aquatic Systems	http://www.ufms.br
	---	Master in Environmental Technologies	Bases of Hydrology; Biology for Environmental Engineering; Chemistry for Environmental Engineering; Environmental Hydrology; Mathematics Applied to Water Resources; Special Study in Environmental Technologies: Hydroelectric Works; Special Study in Environmental Technologies: Interactive Cartography Applied to Water Resources; Unitary Processes to Water and Sewage Treatment; Environmental Planning and Water Resources Management; Environmental Impact Assessment; Systemic Environmental Analysis and of Water Resources; Applied Hydrology.	http://www.ufms.br
		Master in Geography	Environmental Analysis; Environmental Education; Planning and Environment; Physical Aspects of Environment; Water Quality Assessment for River Basins Planning and Management; Continental Hydro-dynamics Systems.	http://www.ufms.br
Universidad Federal do Paraná	Sector de Ciencias Agrarias (Department of Agrarian Sciences)	Agronomy Engineering	Irrigation and Drainage; Hydraulics and Hydrology	http://www.agrarias.ufpr.br
		Forest Engineering	Hydrology and River Basin Management	http://www.floresta.ufpr.br
	Sector de Ciencias de la Tierra	Geography	Hydro-geography; Geography and Environmental Analysis; River Basin Management.	http://www.terra.ufpr.br http://www.geog.ufpr.br

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	(Department of Earth Sciences)	Geology	Hydrogeology; Applied Hydrogeology; Energetic Resources II; Environmental Geology; Basin Analysis; Geo-environmental Risks	http://www.geologia.ufpr.br
	Sector de Tecnología (Department of Technology)	Environmental Engineering	Introduction to Environmental Engineering; Environmental Hydrology; Environmental Sanitation I; Environmental Sanitation II; Geographical Information System Applied to Environment.	http://www.ufpr.br/
		Civil Engineering	Engineering Water Resources Engineering	http://www.ufpr.br/
		Chemical Engineering	Effluents Treatment	http://www.ufpr.br/
	Sector de Ciencias Exactas (Department of Exact Sciences)	Chemistry	*Optional:* Ecology; Environmental Chemistry; Environmental Sciences I.	http://quimica.ufpr.br/cquim/cquim.html
	Sector de Ciencias Jurídicas (Department of Law Sciences)	Law	Environmental Law	http://www.direito.ufpr.br/
Universidad Federal de São Carlos	Centro de Ciencias Agrarias (Department of Agrarian Sciences)	Agricultural Engineering	Environmental Sciences; Agricultural Hydraulics; Environmental Sciences; Water Relations in Soil-Plant-Atmosphere System; Irrigation and Drainage; Pollution and Environmental Impacts; Environmental Hydrology; Phyisical Analysis of the Environment; Ecologic Economy and Environmental Assessment.	http://www.cca.ufscar.br
	Centro de Ciencias Exactas y Tecnología (Centre of Exact Sciences and Technology)	Master in Urban Engineering	Urban Sanitation Systems; Management and Control of Sanitation Sytems; Control of Rain Waters on Environment; Environmental Planning and Management; Technologies for Implementation of Sanitation Infrastructure; Enviromental Geology Applied to Urban Areas.	http://ww.ufscar.br/~ppgeu

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Centro de Ciencias Biológicas y de la Salud (Centre of Biologic and Health Sciences)	Master in Ecology and Natural Resources and Doctorate in Biological Sciences (Mention in Ecology and Natural Resources)	Environmental Impact Assessment on Ecosystems; Energetic Ecology; Bio-geochemistry of aquatic ecosystems; Environmental Planning and Conservation; Environmental Education; Methodology of Intervention and Research in Enviromental Education.	http://www.ufscar.br/~ppgern
Universidad Federal de Uberlândia	Facultad de Ingeniería Civil (School of Civil Engineering)	Master in Civil Engineering (Area of Urban Engineering)	Treatment System in Water Supply; Impacts of Rain Waters on Environment; Urban Sanitation Systems; Special Topics in Sanitation.	http://ww.feciv.ufu.br/posgraduacao
Federal de Sao Paulo	Instituto de Geociencias (Institute of Geosciences)	Master and Doctorate in Mineral Resources and Hydrology (options: Mineral Resources and Environment; Hydrology and Environment).	Aquifers Management; Environmental Geology; Bio-geochemistry of Aquifers; Geoprocessing Applications to Environmental Studies; Hydrogeology; Geochemistry of Soil-Rock-Water Interaction; Special Topics in Economic Geology; Hydrology and Enviroment I.	http://www.igc.usp.br/ensino/pos_graduacao/
	--	Master and Doctorate in Environmental Science		http://www.igc.usp.br/ensino/graduacao
Estadual de Campinas	Instituto de Geociencias (Institute of Geosciences)	Master and Doctorate in Geology and Natural Resources	Law of Natural Resources; Groundwater Resources Management; Development, Environment and Natural Resources; Geotechnologies Applied to Natural Resources Studies; Geosciences and Environment.	http://www.ige.unicamp.br/
Estadual de Campinas	Facultad de Ingeniería Civil,	Master and Doctorate in Civil	Introduction to Hydraulic Lot Systems Engineering; Complements to Hydraulics; Complements to	http://www.fec.unicamp.br/pos/

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
	Arquitectura y Urbanismo (School of Civil Engineering, Architecture and Urbanism)	Engineering (Areas of Structures, Geotechnique, Water Resources, Sanitation and Environment, Transport)	Hydrology; Seminaries on Water Resources; Hydraulic Structures; Hydroelectrical Works; Irrigation: Project and Techniques; Drainage of Rain Waters; Alternative Techniques for Treatment of Water Supply; Introduction to Hydraulic Models; Hydraulic Engineering Applied to Water Supply Systems; Technologies of Water Treatment for Small Communities; Instruments of Environmental Management in Transport; Water Resoruces Planning; Numerical and Computer Methods in Hydraulic Engineering; Hydraulic System Optimisation; Topics on Hydraulics; Topics on Hydrology; Hydro-meteorology; Topics on Environmental Engineering; Environmental Planning; Static Hydrology; Environmental Management; Physics-chemical Processes Applied to Water Treatment; Analytical Methods Applied to Water-Soil-Atmosphere System; Sanitation Quality of Water; Planning, Environmental Impacts Assessment and Geographical Information Systems; Concept and Practice in Environmental Planning; Environmental Management in Urban Areas; Environmental Law.	
	Facultad de Ingeniería Agrícola (School of Agricultural Engineering)	Master and Doctorate in Agricultural Engineering		http://www.agr.unicamp.br
Estadual de Londrina	Centro de Ciencias Exactas (Centre of Exact Sciences)	Master in Geography, Environment and Development	Pollution Control and Environmental Management; Urban-regional Formation and Environment; Geoprocessing Applied to Environmental Analysis; Climate and Environment; Geomorphology and	http://www.geo.uel.br

University	School / Department	Post graduate career	Courses (related to water and environmental issues)	Web site
			Environmental Analysis; Land Use and Environmental Impacts; Special Topics on Environment and Development; Environmental Cartography; Groundwater Resources; Environmental Geology.	
Estadual de Maringá	Centro de Ciencias Agrarias (Centre of Agrarian Sciences)	Master and Doctorate in Agronomy	Irrigated Agriculture; Water Management in Agricultural Production; Water-Plant Relation; Soil-Water-Plant-Atmosphere System.	www.pga.uem.br/
	Centro de Ciencias Humanas, Letras y Artes (Centre of Human Sciences, and Arts)	Master in Geography	Ecology of Natural Resources; Special Topics on Regional Geography and Environmental Analysis; Production of Space and Enviromental Issues in Brazil; Environmental Planning in Urban Areas; Studies in Landscape and Environmental Education; Geo-environmental Cartography; Study of Climates and their Relationship with the Environment; Project of Networks and Monitoring of Water Quality.	www.pga.uem.br/
Estadual de Ponta Grossa	Sector de Ciencias Agrarias y Tecnología (Department of Agrarian Sciences and Technology)	Master in Civil Engineering	Hydraulic-Sanitation Lot Systems	http://www.uepg.br/denge/index.html
Estadual del Oeste del Paraná	Centro de Ciencias Exactas y Tecnológicas (Centre of Exact and Techological Sciences)	Master in Agricultural Engineering	Water Dinamics in Soils; Water Reutilisation; Environmental Sanitation; Wastewater Treatment; Hydraulics; Water-Soil-Plant-Atmosphere Relationship; Surface Irrigation; Management Models in Water Resources.	http://www.unioeste.br/prppg/

- Private institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Página web
de Taubate	Instituto de Biociencias (Institute of Biosciences)	Master in Environmental Sciences	Methodology in Scientific Research in Environmental Sciences; Studies and Analysis of Environmental Processes; Sustainable Development; Energetic Sources and Environmental Policies; Environmental Planning and Management; Environmental Education; Environmental Law; Climatology; Environmental Hydrogeology; Surface Hydrology; Atmospheric Processes and Climatic Variability; Environmental Chemistry.	http://www.unitau.br/prppg.htm
De Riberao Preto	---	Master in Environmental Technology	Water Pollution Control; Soil Pollution Control; Environmental Legislation; Environmental Pollution; Water Pollution; Soil Pollution; Remote Sensing and Geoprocessing and Environmental Monitoring; Topics on Environmental Analysis.	http://www.unaerp.br/

14.2.2.4. Paraguay

- Public institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web site
Nacional del Pilar	---	Specialisation in Agrarian Administration		http://www.unp.edu.py/postgrados/postgrados.htm

- Private institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web site
Americana del Paraguay	---	Doctorate in Law Sciences		http://www.uamericana.edu.py/?contenido=03_Doctorados
Católica Nuestra Señora de Asunción	---	Master in Civil Engineering	*Areas*: Structures and Geotechnique; Hydrology; Hydraulics; Public and Environmental Sanitation	http://www.uca.edu.py
del Norte	Facultad de Ingeniería	Master in Environmental Sciences	Geology and Water Resources; Environmental Legislation; Environmental Sociology; Environmental Policy and Economy; Treatment of Liquid Wastes; Treatment of Solid Wastes.	http://www.uninorte.edu.py/contenido/postgrado_maestrias_cieciaambiental.php

14.2.2.5. Uruguay

- Public institutions

University	School / Department	Programme	Courses (related to water and environmental issues)	Web site
de la República	Facultad de Ingeniería (School of Engineering)	Master in Environmental Engineering	*Levelling courses:* Free Surface Hydraulics and Surface Hydrology; Groundwater Hydrology. *Courses:* Liquid Effluents; Solid Wastes; Surface Water Purification; Water Bodies Pollution.	http://www.fing.edu.uy/servadm/secretaria/comisiones/claustro/maestmfa.html
		Master in Engineering (Applied Fluid Mechanics)		http://www.fing.edu.uy/servadm/secretaria/comisiones/claustro/maestmfa.html
		Master in Chemical Engineering		http://www.fing.edu.uy/servadm/secretaria/comisiones/claustro/dociq.html

University	School / Department	Programme	Courses (related to water and environmental issues)	Web site
		Doctorate in Chemical Engineering		http://www.fing.edu.uy/servadm/secretaria/comisiones/claustro/dociq.html
		Master in Environmental Engineering (Applied Fluid Mechanics)		http://www.fing.edu.uy/cursos/index.htm
		Doctorate in Environmental Engineering (Applied Fluid Mechanics)		http://www.fing.edu.uy/servadm/secretaria/comisiones/claustro/docmfa.html
	Facultad de Agronomía	Master in Agrarian Sciences	Groundwater for agricultural use; Pumps for agricultural uses; Land-Embankment Design; Agricultural Hydraulics; Small Basins Hydrology; Management and conservation of soils and waters; Irrigation Systems I; Irrigation Systems II.	http://www.fagro.edu.uy/posgrados/index.html
de la República	Facultad de Ciencias (School of Sciences)	Master and Doctorate in Biological Sciences		http://www.fcien.edu.uy/
		Master in Environmental Sciences		http://www.fcien.edu.uy/

- <u>Private institutions</u>

Universidad	Facultad	Carrera de Posgrado	Materias	Web site
Católica	Facultad de Ingeniería (School of Engineering)	Master in Food Science and Engineering	Environmental Management of Food Industry	http://www.ucu.edu.uy/

ANNEXES

Annex I. Methodological Issues

I.1. On the use of statistical information

Official statistical information provided by the five countries and international institutions (such as the UN Economic Commission of Latin America and the Caribbean, the World Bank or the Inter-American Development Bank) was used to describe the major socioeconomic and demographic characteristics of the La Plata Basin.

In order to provide a more accurate description of these characteristics, the jurisdictions at the sub-national level and the municipalities (third level), which are included in the La Plata Basin, were determined using ArcView GIS and specifically through the Geoprocessing tool. This tool allows selecting shapes of municipalities of the five riparian countries overlaying the shape of the La Plata basin's limits.

The municipalities of the following provinces, departments, provinces and states were selected:

- In Argentina: provinces of Chaco, Corrientes, Entre Ríos, Formosa, Misiones, Santa Fe and Buenos Aires City (entire jurisdiction); departments of the provinces of Buenos Aires, Catamarca, Córdoba, Jujuy, San Luis, Santiago del Estero and Tucumán;
- In Bolivia: department of Tarija (entire jurisdiction); provinces of the departments of Chuquisaca, Oruro, Potosí and Santa Cruz;
- In Brazil: States of Federal District and Mato Grosso do Sul (entire jurisdiction), municipalities of the states of Goiania, Mato Grosso, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina and São Paulo;
- In Paraguay: all the country;
- In Uruguay: departments of Artigas, Canelones, Cerro Largo, Colonia, Durazno, Flores, Florida, Lavalleja, Maldonado, Montevideo, Paysandú, Río Negro, Rivero, Salto, San José, Soriano and Tacuarembó.

Available data at these three levels were used when possible; when this methodology could not be applied, data for entire the La Plata River Basin countries is presented. In such cases, the reference "by country" is added in the title of the tables.

I.2. On the description of programmes, projects and plans carried out by the national governments of the riparian countries

Information on programmes, projects and plans carried out by governments or other national organisations in Paraguay and Bolivia were identified before the national elections celebrated in both countries in 2006. The changes in the governmental structures after those elections would also change some of the Ministries and other institutions' objectives and projects. That is why the information provided for both Paraguay and Bolivia should be taken as a reference of the activities carried out by those governments.

I.3. On the use of qualitative and quantitative information

The description of the different issues of the La Plata Basin Report was made consulting the latest updated information, using both searching engines on the Internet and specific bibliography. However, it was not always possible to access to complete or updated reports for the five countries. In those cases, two different methodologies were used:

- When information on two or three countries was found, the description was made for those countries only;

- When information on one or two countries was found, specific cases or "boxes" were used to describe the issue. For example, in Chapter 7, Water and Human Settlements, five boxes were used:

- Expansion of sanitation coverage in Uruguay
- Difficulties measuring water loss in Brazil
- Floods in the Metropolitan Area of Buenos Aires
- Ecosystem Protection in the banks of the La Plata River
- Gran Chaco Americano Diagnosis

Regarding quantitative –statistical- information, the main sources were the Statistical Agencies (such as the Argentinean INDEC or the Bolivian INE) or specialised institutions on different issues, as the national Ministries of Agriculture, in the case of agriculture or irrigation. Information provided by FAO, CEPAL/ECLAC and by others international institutions was also used in the report, to describe the situation when no national statistical data were available (such as the cases of Paraguay and Brazil for irrigated crops).

Annex II. List of Ramsar Sites in the La Plata Basin

Wetlands	Area (ha)	Designed data	Main characteristics
1) Humedales Chaco (ARG)	508,000	02-02-04	Covering part of the Paraná and Paraguay Rivers' floodplain complex in the eastern border of Chaco province, limited to the north by the Bermejo River and surrounding the city of Resistencia. The hydrological regimes of each river give rise to different pulses of flood and drought in these wetlands, regulating floods downstream and retaining water in times of drought. The landscape is a complex of open water, aquatic vegetation, grasslands and gallery forests. Wildlife in these forests shares traits with that of the Humid Chaco and the Amazon region, and representative tree species are the "ibira-pitá" (*Peltophorum vogelianum*), the "lapacho negro" (*Tabebuia ipe*), *Nectandra falcifolia* and *Enterolobium contortosilquum*. Several endangered species inhabit the site, including the marsh deer (*Blastocerus dichotomus*), the Neotropical otter (*Lutra longicaudis*), the bare-faced curassow (*Crax fasciolata*). Crocodilians (*Caiman latirostris*, *C. crocodylus*), the coscoroba swan (*Coscoroba coscoroba*), and the endemic South American lungfish (*Lepidosiren paradoxa*) are also found. Economically important fish species are the Sorubims (*Pseudoplatystoma coruscans* and *P. fasciatum*) and "manguruyu" (*Paulicea lutkeni*). Cattle raising and rice crops are important activities, followed by soybean and sorghum. Hydrological changes have been noticeable since the 1960s, with dam building in the Upper Paraná in Brazil, deforestation, and increase in precipitation
2) Parque Nacional Río Pilcomayo (ARG)	55,000	04-05-92	An extensive complex of rivers, lagoons, pools, permanent freshwater marshes and seasonally inundated grassland, interspersed with riparian woodland and gallery forest. Seasonally flooded savannah grassland with palm trees is the dominant habitat type. The site is notable for its rich terrestrial and water-bird populations. The region is increasingly important for tourism, supporting livestock grazing, and unauthorised hunting. A border is shared with Paraguay.
3) Lagunas y Esteros del Iberá (ARG)	24.550	18-01-02	The site is centred about the Iberá Lagoon and is part of the macrosystem of Iberá, a catchment area of some 1.3 million hectares drained by the Corriente River

Wetlands	Area (ha)	Designed data	Main characteristics
			into the middle reaches of the Paraná, representative of wetland types found in Corrientes and southeastern Paraguay. Iberá Lagoon, at 5,500 ha, is one of the largest and most characteristic components of the system with an average depth of 3 m, it is almost always clear with variations caused by seasonal growth of plankton. The site supports high biological diversity, including an appreciable number of endemic species. Among rare, vulnerable, and endangered species covered by CITES within the site are the “yacaré overo” or Broad-snouted caiman (*Caiman latirostris*), “yacaré negro” (*C. Yacare*), “anaconda amarilla” or “curiyú” (*Eunectes notaeus*), the “pato crestudo” (*Sarkidiornis melanotos*), the Neotropical otter or "lobito de río" (*Lontra longicaudis*), and “ciervo de los pantanos”, or Marsh deer (*Blastoceros dichotomus*), among others. The surrounding marshlands of Esteros del Iberá support a sizable number of indigenous fish species and subspecies at key stages of their biological cycles, particularly *Salminus maxillosus*. Agriculture, particularly rice, and grazing are practiced in the area, and the development of ecotourism is foreseen.
4) Jaaukanigas (ARG)	492,000	10-10-01	An extensive complex of rivers, lagoons, pools, permanent freshwater marshes and seasonally inundated grassland, interspersed with riparian woodland and gallery forest, makes this site one of paramount importance from the biodiversity and hydrological point of view in Argentina. The site provides habitat for a large number of species, some vulnerable or threatened with extinction, such as *Lontra longicaudis*, *Tamandua tetradactyla*, *Chrysocyon brachyurus*, *Caiman yacare*, *C. latirostris*, *Eunectes notaeus*, *Tupinambis merianae*, *Boiruna maculata*, and *Hydrops triangularis*. There is an important population of ducks, including *Netta*

Wetlands	Area (ha)	Designed data	Main characteristics
			peposaca, *Dendrocygna bicolor* and *D. viduata*, and migratory birds such as *Calidris melanotos*, *C. fuscicollis*, *C. bairdii*, *Tringa melanoleuca*, *T. flavipes*, *T. solitaria* and *Limosa haemastica* are also found. There is a very rich aquatic life, with about 300 fish species, which are key for the regional economy.
5) Bahía de Samborombón (ARG)	244,000	24-01-97	An extensive, inter-tidal zone, which includes marshes, tidal channels, brackish swamps, and crab and mud flats. Vegetation is predominantly herbaceous, forming a mosaic of communities crisscrossed by meandering freshwater streams, creating a complex hydrological system with a diversity of wetland types. Human activities include cattle ranching, fishing, hunting, firewood cutting and nutria trapping (*Myocastor coypus*). The site is a source for domestic water.
6) Pantanal Matogrossense (BRA)	135,000	24-05-93	Part of the largest, permanent freshwater wetland in the Western Hemisphere. It is situated in a large depression functioning as an inland delta. The area consists of a vast region of seasonally flooded savannas, islands of xerophytes scrub, and humid deciduous forest. The site includes some of the largest and most spectacular concentrations of wildlife in the Neotropics and is probably the most important wetland in South America for waterfowl. There are huge resident breeding populations of a wide variety of species, and Nearctic shorebirds use the area for staging.
7) Lagoa do Peixe (BRA)	34,400	24-05-93	Extensive lowland area of salt-marshes, coastal sand dunes, lagoons, lakes and associated marshes, providing important staging sites for numerous migrant species. Lagoa do Peixe is a large brackish to saline lagoon, supporting large concentrations of invertebrates. The area is very important for a wide variety of waterfowl, and the lagoon is an important wintering and staging area for migrant species. Human activities include hunting, irrigation of rice fields, and harvesting of shrimp (uncontrolled).
8) Cuenca de Tajzara (BOL)	5,500	13-06-2000	The site consists of a group of seasonal, semi-permanent and permanent lakes, high-altitude streams, marshes and high-Andean pastures. The two

Wetlands	Area (ha)	Designed data	Main characteristics
			permanent lakes (areas between 350 and 800 ha) serve as a refuge for 40 species of birds indigenous to the high-Andean aquatic systems, where about 90% of the high-Andean waterfowl in Bolivia is found. The area is important for migratory shore birds, with year-round concentrations of the vulnerable high-Andean waterfowl species Andean flamingo (*Phoenicopterus andinus*), James's flamingo (*P. jamesi*), and *Fulica cornuta*. The main economic activity is the raising of sheep, llamas and cattle; agriculture is limited by the climate, though the families in the area have an average of ½ to 1 hectare for subsistence crops. There is a visitors' centre, a bird-observation site, information material, and facilities for school visits. There are plans to draw up a management plan with the participation of the local communities.
9) Pantanal Boliviano (BOL)	3,189,888	17-09-01	An enormous area on the eastern frontier with Brazil, part of South America's great Pantanal, the world's largest wetland. The vast complex of rivers, lakes, lagoons, marsh, inundated forests and savannahs, and a major source of the Paraguay river, considered being even richer in biodiversity and less disturbed than Brazilian portions, supporting astonishing numbers of floral species and fish, birds, and large mammals. The site also includes the Chiquitano forest, a major extension of the most intext dry forest in the world. Historically populated by Chiquitano and Ayoréode peoples in the southern parts, near the Chaco transitional region, others have joined the region over

Wetlands	Area (ha)	Designed data	Main characteristics
			the past century to pursue cattle grazing and trade with Brazil. Necessary future exploitation of mineral resources must be carefully managed to avoid harm to the region, and expanded cattle grazing may pose a threat to ecological values; deforestation as on the Brazilian side of the border is feared, and the potential effects of the Paraguay-Paraná Waterway project to open the Paraguay to navigation are being watched carefully.
10) Estero Milagro (PY)	25,000	07-06-95	The area is characterised by natural grasslands, low forests, wooded savannas and gallery forest, swamps, small marshes, and a great diversity of plant species. The aggregation of lagoons and marshes on calcareous soils, with characteristic plants, are the only formations of this kind in the country. The site provides important aquatic habitat for migratory birds and other animals associated with aquatic environments, as well as habitat for the survival of several rare species and threatened species of plants. The area is used by the local population for agriculture, ranching, exploitation of forest resources, subsistence hunting, and fishing.
11) Lago Ypoá (PY)	100,000	07-06-95	An area of extensive, shallow, clustered lakes (esterales) with floating mats of vegetation, some supporting small trees and fauna. Esterales are interspersed with forested islands, savannah, rocky areas, and streams. This site provides excellent wildlife habitat and is one of the most important aquatic environments in Paraguay, important for several threatened species, migrating birds, and five species of threatened plants. Timber cutting and livestock rearing occur in the site, while extensive ranching occurs in the surrounding
12) Laguna Chaco Lodge	2,500	20-10-03	Saltwater lake with sharp level fluctuations surrounded by xerophytes woods and shrubs and

Wetlands	Area (ha)	Designed data	Main characteristics
(PY)			halophytic vegetation. The site is one of the few relatively undisturbed natural areas in the Chaco, hosting an impressive biodiversity, including the endangered Chacoan peccary (*Catagonus wagneri*) and the Brazilian tapir (*Tapirus terrestris*). Several wintering shorebird species are abundant, with up to 25,000 Wilson's phalaropes (*Phalaropus tricolour*), 4,000 White rumped sandpipers (*Calidris fuscicollis*), and 3,000 pectoral sandpipers (*Calidris melanotos*), all of them figures above 1% threshold. The same is true for the Chilean flamingos (*Phoenicopterus chilensis*), which are regular on the site. Chaco Lodge is entirely devoted to conservation and small-scale ecotourism and hunting and cattle ranching pressures from the surrounding area are very limited. The greatest threat, however, comes from the intense drought affecting the region the past few years.
13) Laguna Teniente Rojas Silva	8,470	14-07-04	This lake alternates between freshwater and brackish conditions. It supports colonies of Southern cattail (*Typha dominguensis*), Tropical duck-weed (*Pistia stratiotes*) and West Indian marsh grass (*Hymenachne amplexicaulis*), amidst a landscape of xerophytes forest, sub-humid forest, seasonally flooded shrubs and forests and savannah. The site hosts several endangered and protected species such as the greater rhea (*Rhea Americana*), the Coscoroba swan (*Coscoroba coscoroba*), the Chilean flamingo (*Phoenicopterus chilensis*), the giant Brazilian otter (*Pteronura brasiliensis*) and the Southern three-banded armadillo (*Tolypeutes matacus*).. The

Wetlands	Area (ha)	Designed data	Main characteristics
			indigenous shrub (*Lophocarpinia aculeatifolia*) and the Jacare (*Caiman yacare*) are other noteworthy species of the site. The area is part of a private estate whose owners are committed to wetland conservation. Small-scaled agriculture and cattle ranching, as well as local hunting by indigenous people are the main human uses of the site, while its greatest threats are salinisation and desertification, which have already occurred in neighbouring areas.
14) Río Negro (PY)	370,000	07-06-95	A riverine system of meanders and oxbow lakes set in an ecotone arising from the confluence of three biogeographic provinces, with representative fauna from all. Considered a world centre of floral genetic diversity, numerous rare and threatened species of flora and fauna are supported. Some livestock rearing, timber extraction, and poaching take place.
15) Tinfunque	280,000	07-06-95	An alluvial plain along the Pilcomayo River which is flooded much of the year and characterised by patches of forest, extensive, clustered lakes, and savannahs of palm groves. Watercourses follow ancient riverbeds, with gallery forest growing alongside. Another sector is composed of vast, dry plains of grasses and shrubs. Located in the tropical deciduous dry forest biogeographical region, the site, in outstanding condition, is a good representative of biodiversity. Situated along the migration route, birds are abundant in species and number. Several threatened wildlife species (rhea, caiman, turtle, and jaguar) and fish species breed here. The site is important for

Wetlands	Area (ha)	Designed data	Main characteristics
			Potamogeton striatus, a critically endangered plant, and supports a distinct mammalian fauna. Extensive ranching, extraction of forest products, and poaching occur. The site shares a border with Argentina.

Source: RAMSAR, 2004.

Annex III. Detail of political lines and legislation on energy development in the La Plata Basin countries

III.1. Political lines (programmes, projects and other policies in general)

- Argentina

Programa de Pequeños Aprovechamientos Hidroeléctricos PAH *(Small Hydroelectric Operations Programme):* Destined to promoting clean and renewable energies through the construction of hydroelectric works. It was started in 2004, with Inter-American Development Bank (IDB) and national funds, coordinated by the *Subsecretaría de Energía Eléctrica* (Undersecretariat of Electric Energy), of the *Secretaría de Energía de la Nación* (National Secretariat of Energy).

Renewal of Small Hydraulic Systems and Construction of New Generation Plants on Already Constructed Civilian Works: By means of this project, the purpose is to reduce reliance on combustible fossil fuels and, in addition, to create employment opportunities and tend to sustainable development. It was begun in 2004, under the control of the *Subsecretaría de Energía Eléctrica*, of the *Secretaría de Energía de la Nación*.

Application of fuel cells in renewable energies: It involves, among other things, guaranteeing electricity supply in the framework of sustainable development and climate change mitigation. It was started in 2004, the PREMER (WB-GEF) being responsible for its implementation. It encompasses all renewable energy sources, including hydroelectric power.

Programa de Promoción de Energías Limpias y Renovables (Programme for the Promotion of Clean and Renewable Energies): The programme was begun in 2003 at the *Dirección Nacional de Promoción* (National Promotion Directorate) of the *Subsecretaría de Energía Eléctrica*. It incorporates the execution of feasibility studies in order to expand the energy generation capacity of renewable sources, including hydroelectric power. It also includes stimulating the regulating framework for the promotion of this type of energies.

JREC Commitment: Argentina acceded to the Renewable Energy Coalition in 2002, in the framework of the Summit of Sustainable Development. The general purpose is to reduce poverty in the framework of sustainable development. It was started in 2002, promoting the use of renewable energy sources.

Rural Electrification with Renewable Energies: This is about promoting clean and renewable energies in rural areas (2000-2005 period). It is being implemented by the *Subsecretaría de Energía Eléctrica* and includes all the renewable energies.

Secretariat of Energy, Works Plan Resolution 1/2003: The Works Plan made possible by *Secretaría de Energía* Resolution 1/2003 and other regulations is an integral part of the *Plan Energético Nacional 2004-2008* (National Energy Plan). Through this Resolution, the *Secretaría de Energía* enabled an exceptional procedure to identify and enable investments in the sector, actively promoting the expansions required by the Systems of Transport with High Voltage and Trunk Distribution, with the aim to preserve quality and service supply, without implying the exoneration or transfer of freighters' and distributors' obligations.

Programa de Ahorro y Eficiencia Energética en Edificios Públicos, PAyEEE *(Programme for Energy Saving and Efficiency in Public Buildings)*: The *Dirección Nacional de Promoción* of the *Secretaría de Energía* has carried out studies which determine that public buildings could improve electric power efficiency, consumption and costs. On the basis of these studies, the PAyEEE is being promoted. The main feature in this programme will be the joint work of the *Dirección Nacional de Promoción* and the representatives appointed by the different bodies for the plan.

Plan Federal de Transporte Eléctrico II (Federal Plan of Electric Transport II). First Stage – Planning: The *Secretaría de Energía* and its natural advisor in the matter, the *Consejo Federal de la Energía Eléctrica*, CFEE (Electric Energy Federal Council) recognised the need to design and implement solutions for the Regional Transport Systems at 132 kV. Profuse, widely known documentation demonstrates that the delay in investments for this kind of developments is at least as significant as in the national network of extra-high voltage. Such a situation is giving rise to the appearance of transport restrictions that, in the short or medium term, will create the need for load cuts as the only means to overcome peak load hours without running the risk of total collapse. For this reason, in mid-2003 the *Secretaría de Energía* instructed the CFEE to study and create a plan of essential works for the 2004-2008 period, in order to provide solutions for the Regional Electric Transport Systems.

Plan Federal de Transporte de Energía Eléctrica en 500 kV (Federal Plan of Electric Energy Transport at 500 kV): *Secretaría de Energía* Resolution 657/99 (modified by Resolution 174/2000) sets forth the conditions that extensions should meet in order to participate in financing the *Fondo Fiduciario del Transporte Eléctrico Federal*, FFTEF (Federal Electric Transport Trust Fund): (a) works benefiting the Electric System through quality and/or security improvements and/or lower bureaucratic costs; (b) not expected to be carried out only by private firms for reasons of scale; (c) investment advance for a federal expansion.

In the eligibility conditions and in agreement with the flow of funds forecasted for the FFTEF, the following works have been identified as having a positive benefit (corresponding to allocation of funds) conforming the *Plan Federal de Transporte en 500 kV*: (a) COMAHUE-CUYO Interconnection: Improves generation transmission at Comahue and enhances service quality at Cuyo. As from 2003, it is very significant for Cuyo (local prices predictably higher than MEM); (b) Argentinean North West (NOA)-Argentinean North East (NEA) Interconnection: Associated to generation expansion in NOA, providing export potential (export commitments which had to be postponed due to line delay); (c) MEM-MEMSP Interconnection: Allows the optimisation of both systems, improvements in joint operation and "inexpensive" reserve for the MEMSP; (d) CUYO-NOA Interconnection (MINER LINE): More inexpensive supply alternative for mining operations in the Andes range region.

- Brazil

Programa Luz Para Todos (Programme Light for All): The programme aims to take electric power to over 12 million people by 2008. Coordinated by the *Ministério de Minas e Energia*, MME (Ministry of Mines and Energy), with the participation of *Centrais Elétricas Brasileiras S.A.*, ELETROBRAS (Brazilian Power Stations P.L.C.) and the companies under its control, the programme will serve a population equivalent to Piauí, Mato Grosso do Sul and Amazonas states and the Distrito Federal. Electric power installation to the homes will be free of charge for low-income households. For residential consumers with single-phase connection and a monthly consumption under 80kwh/month, rates will be low, as established by the legislation. The goal of the programme is for electric power access to contribute to decreasing poverty and increasing income for those families served.

Programa de Movilização da Indústria Nacional de Petróleo e Gás Natural, PROMINP (Oil and Natural Gas National Industry Mobilisation Programme): PROMINP's objective is to strengthen the national industry of goods and services, focusing on the oil and natural gas area. The Programme's goals, developed jointly with sector companies, will lead to maximising the national industry share in the supply of goods and services, on a competitive and sustainable basis, meeting national and international demands. The aim is to create employment and income in the country by adding value to the local productive chain. The challenge is to develop projects for the increasing of national contents in the specific areas of Exploration & Production, Sea Transport, Supply, and Gas & Energy. Thus, the industry will improve gradually and in a planned fashion aiming to meet demands in the order of US$ 41 billion, coming from the investments that will be made in the oil and gas sectors in the 2003-2007 period.

Programa de Incentivo às Fontes Alternativas de Energia Elétrica, PROINFA (Alternative Sources of Electric Energy Incentive Programme): The PROINFA is a significant tool for diversifying the national energetic structure. Coordinated by the MME, the Programme institutes the dealing of 3,300 MW of energy by the *Sistema Interligado Nacional,* SIN (Interconnected National System), produced by wind and biomass sources, and by small hydroelectric power stations, with 1,100 MW from each type of source. Created on April 26, 2002 by Law 10,438, the PROINFA was reviewed by Law 10,762, of November 11, 2003, which guaranteed the participation of a larger number of states in the Programme, as well as the incentive to the national industry and the exemption for low-income consumers from payment of the new energy purchase. The PROINFA will have the support of the BNDES, which created a support programme for investments in renewable alternative sources of electric power. The credit line will include up to 70% financing of the investment, excluding only imported goods and services, and land purchases. In the long-term energy purchase contract, ELETROBRAS will guarantee the entrepreneur a minimum revenue of 70% of the agreed amount of energy during the financing period and overall protection regarding short-term market exposure risks. Contracts will have 20-year duration and involve selected projects, which must start operating by December 2006.

With the establishment of the PROINFA, it is estimated that 150 thousand direct and indirect jobs will be created during work construction and operation. Private sector expected investments are in the order of R$ 8.6 billion. One of the Law 10,762 requirements is the obligation for a minimum nationalisation rate of 60% of the total project construction cost.

Brazil has suspended the technologies for the production of equipment for biomass powerhouse and small hydroelectric power station use, and is moving forward with wind technology, with two installed factories, one of them in the Southeast and the other in the Northeast. The regionalisation criteria included in Law 10,762 set an allocation limit for each state of 20% of the overall capacity destined to wind and biomass sources, and 15% for small hydroelectric power stations. This gives all the states having a vocation and approved and licensed projects the opportunity to participate in the programme. However, the limitation is preliminary, since, should the full amount of 1,100 MW destined to each technology not be commercialised, the non-commercialised potential would be distributed among the states possessing the oldest environmental licenses. In order to participate in the Programme, endeavours will need a previous installation license.

With regard to the country's electric power supply, the PROINFA will be a tool of seasonal energy complement to waterpower, which accounts for over 90% of the country's generation. In the Northeast region, wind energy will serve as a complement to hydraulic supply, for the rain season is opposite to the wind season. So will be the case with biomass in the South and Southeast regions, where the harvests of those crops suitable for electric power generation (sugarcane and rice, for example) take place in a period other than the rain period. The production of 3.3 thousand MW from renewable alternative sources will double the share of wind, biomass and small hydroelectric power station sources in the Brazilian electric power structure. These sources currently account for 3.1% of the total produced, and they could reach 5.9% in 2006.

In Brazil, 41% of the energetic structure is renewable, while the world average is 14% and, in developed countries, only 6%, according to National Energy Balance (2003 edition) data. The introduction of new renewable sources will prevent the emission of 2.5 million t of coal gas per year, enhancing the business opportunities with a Certification of Carbon Emission Reduction in the terms of the Kyoto Protocol.

The Programme will also allow a greater participation of small electric power producers, diversifying the number of agents in the sector. Also, the Programme will include the installation of 3,300 MW of capacity, which will be incorporated into the National Integrated Electric System (1,100 MW of this sum will be from wind sources, 1,100 MW from small hydroelectric power stations, and 1,100 MW from biomass projects). The energy produced by the selected generating units will be purchased by ELETROBRAS. The contracts between generators and ELETROBRAS will have a 20-year duration, starting from the beginning of operation.

<u>Small Hydroelectric Power Stations</u>: These are powerhouses with an installed capacity of over 1 MW and equal to or below 30 MW which meet the requirements of the specific *Agência Nacional de Energia Elétrica*, ANEEL (National Agency of Electric Energy) resolutions. Since these operations tend to meet the demands near load centres, in areas that are marginal to the transmission system, small hydroelectric power stations play an increasingly relevant role in the promotion of the development of the generation distributed in the country. According to ANEEL data, a total of 3,669.30 MW in small hydroelectric power stations is being authorised for operation, 403.8 MW of which have already started their works. Most small hydroelectric developments in operation are located in the South and Southeast regions, in the Paraná and Southeast Atlantic basins, near the large electric power consumption centres. The Centre-West region, where most of the other developments are located, concentrates the largest potential for new projects.

III.2. Legislation

- <u>Argentina</u>

National Decree 2,407/1983 (Fuels)

Law 25,239/1999 (Tax Reform)

Resolution 6/1998 (Fuels)

Resolution 419/1998 (Hydrocarbons)

Resolution 25/2000 (Fuels)

Resolution 1,103/2004 (Hydrocarbons)

Resolution 1,102/2004 (Hydrocarbons)

- Brazil

Decree 10,438 of 04/26/2002. Expansion of the supply of emergency electric energy, extraordinary rate adjustment; creation of the PROINFA; creation of the *Conta de Desenvolvimento Energético*, CDE (Energy Development Account); enforcement of the generalisation of the electric energy public service.

Law 9,993 of 07/24/2000. Financial compensation resources for the use of water resources for electric energy generation purposes.

Annex IV. Consultation to national experts

Several experts in water resources were consulted on issues described in Chapter 12, Sharing Water, and Chapter 13, Valuing Water. The following questionnaire was sent by email to them:

- *Sharing Water*

1. What types of mechanisms are there in your country to allocate the water resource to the different user sectors, including traditional water rights and water needs for ecosystems? Are there any established rules? How do users participate? Are there any rules that show how to determine environmental flows?

2. How are traditional or consuetudinary water rights considered? Are there any conflicts related to them?

3. What cases of competition for water would you mention as examples within the La Plata Basin? How were these cases approached?

4. What national/international agreements would you mention as examples within the La Plata Basin?

5. Indicate the legislation in your country -type of rule, number and content summary, if possible- to allocate the water resource among different sectors.

6. What experiences are there in your country in connection with this issue? (Virtual water)

7. What experiences are there in your country concerning water allocation based on sharing benefits?

- *Valuing Water*

1. How does your country's water policy take into account water's cultural, social and economic value?

2. How is access to water by the poor dealt with in your country, taking into account equity and MDGs?

3. How does your country's water policy take into account women's role?

4. Has your country become aware of the role water plays in eradicating poverty? How does this awareness translate into?

5. Indicate if there has been a privatisation process in your country. If so, indicate what areas have been reached, the way in which privatisations were undertaken and what experiences can be highlighted.

6. Indicate how tariffs are set in your country for water for domestic uses in rural and urban areas, and for industry and irrigation.

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