



The Framework Program for the Sustainable Management of La Plata Basin's Water Resources, with respect to the effects of climate variability and change



Strategic Action Program for the La Plata Basin SAP



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Strategic Action Program for the La Plata Basin

SAP

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SAP

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The Pantanal in the upper basin of the Paraguay River.

Executive Summary

The La Plata Basin, with an area of approximately 3.1 million km², is formed by the water systems of the Paraguay, Paraná, Uruguay, and La Plata rivers, and can be subdivided into seven sub-basins: Upper Paraguay, Lower Paraguay, Upper Parana, Lower Parana, Upper Uruguay, Lower Uruguay, and the sub-basin of the La Plata River itself. Its current population exceeds 110 million people, and it includes the cities of Buenos Aires, Sucre, Brasilia, Asunción, and Montevideo, the respective capitals of the five countries that make up the Basin: Argentina, Bolivia, Brazil, Paraguay, and Uruguay. The wealth of its natural resources has attracted a large population to the Basin, which today favors its economic development.

This large area is also rich in groundwater resources. It coincides in large part with the Guarani Aquifer System (GAS), one of the largest subterranean water reservoirs in the world, while to the west is the Yrenda-Toba-Tarijeño Transboundary Aquifer System (YTTAS), which coincides mostly with the semiarid Gran Chaco Americano zone. It also houses the largest system of river wetlands on the planet —connected in the center by the great rivers Paraguay,

Parana and La Plata— and is widely recognized by the amount, variety, and endemism of species of fish. By 2015, there were 601 protected areas, 29 Ramsar Sites, and 18 Biosphere Reserves (MAB-UNESCO).

Agriculture is the main economic activity in the Basin. The main crops correspond with annual cycles: soybeans, wheat, corn, and rice, the latter produced with floodwater irrigation, as it requires large amounts of water.

Industrial activity is diversified and particularly connected to the major urban centers in Argentina and Brazil, where the automotive industry and petroleum derivatives represent the principal products. The mining industry also plays an important role in the economic activities of the countries in the region. The Basin possesses the very important capability of generating hydroelectric power —one of the largest energy resources in the world— and its exploitation represents a good portion of the energy generation in the countries that make up the Basin.

Navigation is conducted on the Paraguay-Parana and Uruguay waterways be-

low the Salto Grande dam, and on the Tietê-Parana waterways all the way to the Itaipu dam.

The natural population growth in both urban and rural areas, associated with the strong growth of agricultural and industrial activities, has significantly increased the use of hydraulic resources, particularly those from underground sources, whose extraction can exceed 100,000,000 m³/year in some areas. With the growth of the cities, water supply sources are often overexploited or contaminated, which results in a health risk for the population.

Deforestation driven by agriculture has reduced the capacity of the earth to capture and store carbon and water and anchor the soil, leading to increased erosion rates in some places and sedimentation in others. On the other hand, when the fragility of the territory is accounted for, in this sense most of the sediment production comes from the upper basins of the Bermejo and Pilcomayo rivers.

In the center-east part of the basin lies the Selva Misionera Paranaense (SMP). In this area, there has been a gradual loss of forest mass since the mid-twentieth century, as it is replaced by pastures, agricultural crops, and tree plantations, leading to extraordinary degradation of the soil, changes in hydrological cycles, and local climatic fluctuations. This ecoregion is still considered a high priority for conservation.

The integration process

In 1969, the governments of Argentina, Bolivia, Brazil, Paraguay, and Uruguay signed the La Plata Basin Treaty, the main legal instrument of the Basin. It was through this treaty that the Intergovernmental Coordinating Committee of the Countries of

the La Plata Basin (CIC) was formed as the official body to promote its objectives. The CIC was created in February 1967 during the First Meeting of Foreign Ministers of the La Plata Basin, wherein participating governments agreed to conduct a joint comprehensive study of the area with the intention of collaborating on multinational, bilateral, and national projects for the progress and development of the region.

The institutional framework for regional integration was later strengthened by the Asuncion Treaty, which created the Common Market of the South (Mercosur) in 1995, intended to encourage intraregional and international trade amongst the countries involved.

Since its inception, the CIC has focused on areas of common interest in the five countries, facilitating studies and programs in the areas of hydrology, natural resources, transportation and navigation, soil, and energy.

The Framework Program of the La Plata Basin

During the IV Inter-American Dialogue on Water Management (Foz do Iguacu, Brazil, 2001), the countries of the La Plata Basin agreed to carry out a regional program to advance integrated management of the water resources of the Basin in relation to climate. From this initiative and within the scope of the CIC, funding was obtained from the Global Environment Facility (GEF) for the preparation and implementation of the *Framework Program for the Sustainable Management of La Plata Basin's Water Resources, with respect to the Effects of Climate Variability and Change* (Hereinafter the *Framework Program*). These activities received technical and operational support from the Department of Sustainable Development of

the General Secretariat of the Organization of American States (DSD-GS / OAS), within the framework of a collaborative agreement signed by the CIC and the United Nations Environment Programme (UNEP), as the GEF implementation agency.

The principal objective of the Framework Program was to strengthen cross-border cooperation between the governments of Argentina, Bolivia, Brazil, Paraguay, and Uruguay to ensure the management of shared water resources in the Basin in an integrated and sustainable way, in the context of climate variability and change, capitalizing on opportunities for development.

The Framework Program included a first draft of the formulation (2003-2005), and then a preliminary analysis of the main environmental problems and the challenges to overcome in the La Plata Basin was carried out. Through a process of broad institutional participation, the state and behavior of water systems was characterized, synthesizing the main Critical Transboundary Issues (CTIs) both current and emerging with their respective associated causal chains. Preliminary proposals were identified, as well as gaps in information. Subsequently, Stage 1 of the Framework Program was carried out (2010-2016), allowing for the deepening of knowledge about various aspects of the basin and analyzing the Transboundary Diagnostic Analysis (TDA), considering the effects of climate variability and change and formulating the Strategic Action Program (SAP) for the La Plata Basin.

During the formulation of the Framework Program (2003-2005) and the implementation of Stage 1 (2011-2016), the following Critical Transboundary Issues (CTI) were established in the La Plata Basin, analyzing their main causes and making recom-

mendations to address them: extreme hydrological events, loss of water quality, sedimentation of waterways and bodies of water, disruption and loss of biodiversity, unsustainable use of fishery resources, unsustainable use of aquifers in critical areas, water use conflicts and the environmental impact of irrigated crops, lack of disaster contingency plans, poor water health and the deterioration of environmental health, navigational limitations, and the limited development of hydroelectric potential.

The implementation of Stage 1 has allowed for the initial installment of integral management capacity in the Basin under the CIC through the joint work of national institutions from the five countries updating the TDA as a foundational technical tool for the SAP formulation in the context of the current and future challenges related to climate variability and change.

Bases conceptuales del PAE

Vision and objectives

Following the process of updating the TDA and putting forth its respective recommendations, the following vision and objectives for the SAP of the La Plata Basin was created:

Vision: The countries of the La Plata Basin, strengthened by the shared management of water resources, achieve sustainable development and the welfare of their inhabitants, overcoming critical transboundary issues and in consideration of the effects of climate variability and change.

SAP objective: To promote the management of shared water resources, cooperation and regional integration, while seeking to achieve sustainable development in the La Plata Basin countries and the welfare of their inhabitants.

In addition, qualitative targets associated with each CTI were established, and recommendations on the basis of the aforementioned causal analysis, defining objectives / recommendations for achieving these qualitative targets were consolidated and prioritized.

Consolidation of Recommendations and Definition of the SAP Structure

The recommendations based on the CTIs and categorized as technical, economic-managerial, politico-institutional and socio-cultural, were subsequently consolidated into six SAP strategic areas which in turn contain 13 components and 28 strategic actions.

The strategic areas are: I. Information Management; II. Planning, Management, and Sustainable Use of Water Resources; III. Environmental Protection/Rehabilitation; IV. Education, Communication, and Public Participation; V. Research and Technological Development; and VI. Institutional Strengthening.

The nucleus of the SAP consists of strategic areas II and III. The first is more oriented toward the future, organizing water management in the context of sustainable development.

The perspective of the second is to preventatively remedy environmental liabilities and to prevent further environmental degradation, depending on the use and management of water and soil resources, within the framework of climate variability and change.

Strategic areas IV and V are transverse. The first aims to deepen ties with society and public participation, with a goal of creating action items around education aimed at

training on critical issues for the development of La Plata Basin. The second aims to deepen knowledge about the processes involved, reducing information gaps and developing new technologies in the interest of solving the CTIs.

Finally, strategic area VI aims to support all SAP activities through the development and strengthening of the institutional frameworks necessary for the implementation of the program.

Strategic Areas, Components, and Strategic Actions of the La Plata Basin SAP

The structure of the SAP includes six strategic areas with components and strategic actions as follows:

Strategic Area I **Information Management – Support System for Decision-making (DSS) in the Field of Integrated Water Resource Management (IWRM) of the La Plata Basin**

Incorporates actions related to searching, identifying, integrating, processing, and disseminating the information needed to support decision-making in integrated water resource management in the context of climate variability and change, including early detection systems and hydro-environmental monitoring.

Component I.1 **Networks and information systems**

Aims to expand, consolidate, and integrate the information necessary to deepen understanding of hydro-meteorological and hydro-environmental phenomena, taking into consideration the networks and systems developed in these areas in all five countries.

I.1.1. Expansion and consolidation of monitoring networks. Aims to promote the expansion and consolidation of observation networks, whether they are hydrological, climatic, hydro meteorological, water quality, sediment transport, or aquifers level observation stations, among others. The information is an initial link for both information systems and for monitoring and alert systems for the IWRM of the La Plata Basin.

I.1.2. Expansion and integration of information systems. Aims to promote the expansion and integration of cartographic databases and digital libraries on studies, macro and micro regional plans, territorial plans, and water resource plans. This information is part of that initial link.

Component I.2

Hydro-environmental monitoring and hydrological warning

The operational part of the Decision-making Support System for the La Plata Basin (DSS-La Plata) and aims to design and implement the hydro-environmental monitoring system in the Basin and consolidate the critical hydro meteorological event alert system.

I.2.1. Design and implementation of a hydro-environmental monitoring system in the La Plata Basin. Hydro-environmental monitoring aims to be a tool that provides information for decision-making regarding pollution risks and the risk of disruption of ecosystems, among other things, with the goal of promoting the implementation of control and mitigation measures for ecological and environmental risk. Both the strategic actions of networks and of information systems will be the integrative link for

national or transboundary data, which later will be used for hydro-environmental monitoring, where national organizations will have a space for common action.

I.2.2. Consolidation of the hydrological alert system for the La Plata Basin. The critical hydro meteorological event warning system will present information for decision-making regarding floods and droughts, as well as components for navigation, hydroelectricity, and agrometeorological forecasting, such as farming associated with food security.

Strategic Area II Planning, Management, and Sustainable Use of Water Resources

Includes planning and management actions aimed at strengthening prevention and CTI control mechanisms affecting the Basin, seeking to take advantage of potential water resources to improve the quality of life of the population within the framework of climate variability and change, and also seeking to strengthen the objective to integrate the Basin countries through actions related to the development and sustainability of potential water energy and transport.

Component II.1

Integrated water resource management and adaptive measures

Includes actions aimed at reducing ecosystem vulnerability through integrated management of water resources as an integral piece of the broader sustainable development management in the Basin.

II.1.1. Integrated management of surface and groundwater in critical areas. Provides for the development of actions to enable or improve water resource use in ecosys-

tems or critical areas in order to expand and improve access to water resources for productive development and for the needs of the population. In particular, it promotes sustainable use of aquifers to meet development needs, seeking to increase and regulate the supply of water and its efficient use in order to reduce tensions and potential impacts in areas under water stress.

II.1.2. Land use planning and restructuring in priority vulnerable areas. Seeks to improve urban and land planning, promoting land use planning as a basic instrument to guide the use of the territory and economic activities based on the proclivity of natural resources, seeking to increase resilience and reduce vulnerability to extreme events, particularly floods and droughts.

II.1.3. Water supply management program. Includes actions aimed at guaranteeing water supply for human and productive activities, so as to be able to cope with periods of low flows and droughts or any imbalance between supply and demand resulting in restrictions on water consumption and, consequently, on economic and regional development. Similarly, it includes activities to ensure that water quality standards clearly defined for specific uses are met, either in normal situations or especially facing the occurrence of accidental contaminant spills.

II.1.4. Risk management and adaptive measures program. Aims to develop activities for integrated risk management, acting in different natural disaster-related dimensions such as: disaster prevention through improved preparation of both civil society and responsible institutions; mitigation of the effects of

disasters; reducing vulnerability and potential loss of or damage to life and property; and long-term risk prevention by acting on the cause.

Component II.2

Sustainable Productive Development

Aims to improve income and the quality of life of small producers and communities, particularly those located in vulnerable areas, revaluing the environmental function of ecosystems and the multiple potential uses of water resources available in the Basin. To this end, actions will be carried out aimed at implementing sustainable production practices and soil, water, and ecosystem protection to promote the advancement of fishing and aquaculture, ecotourism, and the use of clean technologies. In developing these actions, the main focus will be on food security, taking into account the effects of climate variability and change.

II.2.1. Promote farming systems resilient to climate variability and change. Includes actions to address water shortages as well as greater availability of water resources, addressing the concept of resilience in production systems. Activities are focused not only on developing robust food systems despite climatic disturbances, but also on ensuring the ability to adapt, respond, and recover from extreme events, helping reduce potential impacts.

II.2.2. Sustainable fisheries and aquaculture programs. Seeks to promote the rational and sustainable use of fishery resources. To this end, it will work at different levels to develop and promote integrative policies, standards, and criteria that are consistent throughout the Basin, acting

in particularly critical and vulnerable areas with actions aimed at strengthening local capacities for developing management and control mechanisms and implementing actions to prevent and reverse the reduction in fishable stock.

II.2.3. Ecotourism program. Made up of actions aimed at promoting ecotourism as a way to improve income in local communities, and as a strategy for protecting ecosystems and managing protected areas. Particular attention is given to the Lower Uruguay sub-basin, which has a series of islands and coastal wetlands that require management attention.

II.2.4. Clean technology program. Focuses on activities aimed at promoting policies and programs that encourage the use of clean technologies and waste minimization, improving income and quality of life for small farmers and communities.

Component II.3 Water Resource Use in the Context of Regional Integration

Seeks to precisely identify the potential impacts of climate variability and change in the sectors of energy and navigation, proposing adaptive measures that help reduce or mitigate their main effects.

II.3.1. Enhance river navigation as a mode of transportation and regional integration. Activities are aimed at promoting the development of navigation in the La Plata Basin, seeking to overcome the main obstacles to transboundary river navigation, considering the potential impacts of climate variability and change.

II.3.2. Defining hydroelectric systems in the context of climate variability and change. Seeks to reduce the vulnerability of the

energy sector, given the uncertainty of current climate models to predict future precipitation levels in watersheds, and the consequences that could have for energy generation.

Strategic Area III Environmental Protection/Rehabilitation

Seeks to strengthen ecosystem conservation mechanisms and the prevention and control of environmental degradation processes affecting the La Plata Basin within the framework of climate variability and change. These actions are aimed at the recovery and conservation of soils and the reduction of erosion and eradication or reducing of pollution sources in order to mitigate negative effects on human health and promote the implementation of measures that contribute to urban sanitation.

Component III.1 Ecosystem Management

Includes actions to contribute to the sustainable management of biodiversity to ensure its conservation.

III.1.1. Conservation and expansion of protected areas and sustainable management of riparian and wetland ecosystems. Will promote the management of the most significant threats to protected areas, including wetlands and transboundary Ramsar sites. It contemplates establishing agreements and guidelines for the protection of transboundary wetlands and protected areas; the conservation and restoration of riparian ecosystems; the consolidation of transboundary protected areas; and the protection of endangered species, habitats, and vulnerable ecosystems, connecting core areas through corridors in order to encourage the recognition of their ecological im-

portance and social, economic, cultural, scientific, and recreational value.

III.1.2. Management of aquatic and other associated ecosystems. Refers to management of aquatic resources and aquaculture. Its implementation will stem from the consolidation of existing diagnostics in critical cross-border areas in order to control and manage invasive, exotic, and alien aquatic species, and meet demands for the protection and rehabilitation of ecosystems in areas where there are dams or other water structures, also seeking to propose climate change adaptive measures targeting conservation for endangered species.

Component III.2 Sustainable Land Management

Includes actions aimed at controlling erosion and sedimentation in critical areas, as well as implementing best practices in management and conservation of soil and water to control diffuse erosion.

III.2.1. Land recovery and erosion control. Establishes the basis for creating a Soil Conservation Program in the La Plata Basin, which creates space for agreements between countries to control the environmental and economic impacts associated with erosion, and for the formulation of adaptive measures to climate variability and change in order to mitigate their effects on water and soil resources.

III.2.2. Local conservation and sustainable land management. Focuses on the same problem as the previous action, but with a different emphasis in terms of scale and scope, giving preference to mitigating diffuse erosion determined by changes in land use and coverage at the small farm level.

Component III.3 Environmental Sanitation

Aims to reduce or solve transboundary problems caused by pollution and reduction of (organic, chemical, and solid) waste sources. Also, considering the deficiency/lack of basic sanitation, it attempts to set reduction and recovery targets as agreed upon by countries for control and mitigation.

III.3.1. Reduction of pollution sources. Aims to reduce pollution sources, one of the most prominent environmental impact problems in the La Plata Basin, originating with the lack of control over organic, chemical, and solid waste pollution sources caused by industrial activity, mining, and agriculture. It includes implementing programs for solid waste management and handling agrochemicals.

III.3.2. Urban sanitation and health. The objective of this action is to identify cross-border problems caused by lack of basic sanitation and to establish restoration goals that may be agreed upon by all countries for their control and mitigation to improve the health of the population. Activities include supplying drinking water in critical urban areas, considering climate change adaptation measures, the protection of urban aquifers, the treatment of urban wastewater, and developing health plans associated with the treatment and mitigation of waterborne disease.

Strategic Area IV Education, Communication, and Public Participation

Addresses actions that aim to educate, raise awareness, train, disseminate information, and prepare society to achieve more

and better participation in the resolution of CTIs and sustainable development in the Basin. Through education, it seeks to raise awareness around specific problems and stimulate the adoption of appropriate practices for sustainable development. Training and rural expansion, meanwhile, seek to capacitate water and soil users in rural areas to implement more sustainable practices. And finally, by way of communication and public participation, it proposes to disseminate relevant information about the problems facing the Basin by providing support to the programs and promoting avenues of participation.

Component IV.1
Environmental Education

IV.1.1. Environmental education program. Proposes to develop and implement a citizens' education and awareness program on sustainable development issues in the context of climate variability and change. The program will focus on socio-environmental issues such as sanitation, sustainable use of aquifers, risk prevention and mitigation, and sustainable tourism, guiding and catalyzing social participation in its implementation. It will promote the use of suitable pedagogical criteria locally adapted for the social and topical context in each country.

IV.1.2. Training and rural outreach, tec program. Includes training programs, expansion, and awareness-building around water resource management practices, ensuring IWRM and soil conservation. It also includes training in native aquaculture production and sustainable fishing, agricultural techniques, sustainable forestry and mining, and recovering knowledge and traditional practices from each of the countries.

Component IV.3 Communication and public participation

IV.1.3. Social communication and public participation program to promote awareness and social participation. Proposes to carry out an awareness-building, communication, and information program tailored to the different national, regional, and social realities in order to boost actions designed to improve water resource management and the treatment of different CTIs. The goal is that through the Communication Program, society is informed and involved in the environmental situation of the La Plata Basin and, in particular, on the effects of climate variability and change.

Strategic Area V
Research and Technological Development

Aims to support and promote research, technological advancements, and innovation for generating information and technologies of interest for the treatment of the CTIs in the Basin.

Component V.1
Research and technological development

V.1.1. Support research development, technological development, and innovation associated with the CTIs. Involves the development of research and technologies to be applied to solve the CTIs in different problem areas, including: vulnerability of coastal habitats, erosion, sediment generation and transportation, the relationship between surface and groundwater (integrated hydraulic balance), integrated ecological flow, integrative and participatory watershed management, technologies for increasing availability and efficient use of water for irrigation, and environmental sanitation and health.

Strategic Area VI **Institutional Strengthening**

Includes proposals for adaptations to the institutional and legal order necessary to facilitate the implementation of the SAP. From an institutional perspective, it includes actions to strengthen the Intergovernmental Coordinating Committee of the Countries of the La Plata Basin (CIC) and national agencies acting on water resources and related areas, as well as improving the relationship and procedures regulating their interactions. From a legal standpoint, it will seek to harmonize laws and establish common or compatible standards and protocols in the five countries in order to achieve greater uniformity on the fundamental principles that can facilitate the realization of the objectives of the Framework Program and strategic actions and SAP activities.

Component VI.1 Institutional Framework

Aims to address the weaknesses of the existing institutional framework in addressing the CTIs, including actions for strengthening and institutional coordination that facilitate the integrated management of water resources at the basin level and guide development processes in sustainability conditions.

VI.1.1. Strengthening the CIC as an organization for coordination and institutional linking for the purpose of SAP implementation. Proposes actions aimed at strengthening the CIC, expanding its powers, and enhancing its technical and administrative resources, as well as at adapting bi-national and regional joint proceedings.

VI.1.2. Strengthening national agencies in the SAP implementation stage. Includes strengthening the various na-

tional bodies involved in shared water resource management responsibilities, taking into account the weaknesses and institutional requirements for managing agencies competent in responding to the CTIs within a framework of climate variability and change. The actions to strengthen national organisms will focus on covering their needs in relation to implementing the SAP, and on incremental costs associated with supporting actions at the regional level.

Component VI.2 Legal Framework

Considers the adaptation and harmonization of national legal frameworks related to the joint management of water resources in the La Plata Basin.

VI.2.1. Harmonization of national legal frameworks for transboundary water resource management, including agreements between countries. Considers actions aimed at promoting agreements between countries, as well as the adaptation of national legislation that enables a homogeneous legal framework.

VI.2.2. Developing common technical guidelines and protocols for actions aimed at enabling the management of shared hydraulic resources. Refers to the establishment of common or compatible regulations, protocols, and standards in order to facilitate the implementation of the SAP.

Final Considerations and Foundations for Implementing the SAP

The Strategic Action Program was designed as an instrument to coordinate policies for water resource management and related environmental issues within the context of current and future challenges related to climate variability and change in the

La Plata Basin. The SAP has a long-term vision and considers the main Critical Transboundary Issues as barriers to overcome to promote sustainable development.

This SAP for the La Plata Basin has a planning horizon of 20 years, and includes six (6) strategic areas, 13 components, and 28 strategic actions. The combination of these strategic actions and the 130 activities that comprise them constitute the intervention response and management recommendations aimed at resolving or mitigating the impacts of the main Critical Transboundary Issues affecting the Basin (based on the analysis of the identified causes) and to promote their sustainable development.

A programmatic approach is anticipated for the implementation of the SAP. Under this approach, strategic areas or specific components may be developed and simultaneously executed, taking into account specific issues (hydro meteorological monitoring and warning, water supply, ecosystem management, reduction of pollution sources, etc.). The timing and implementation schedule of these actions under the program as a whole will depend on obtaining the necessary financing for implementation. In the short term, it is expected that funding will be sought out for the implementation of selected projects in

each of the strategic areas, addressing the most important aspects identified to solve the critical issues of the Basin, catalyzing the acquisition of new sources of funding to energize the and implementation of the other SAP actions.

The strategic actions of the SAP will cover various territorial areas, covering in some cases the entire basin, and in others, the specific areas located in certain sub-basins. Just as the scope of action will be diverse, so too will be the agencies and institutions that will take charge of the implementation of the actions. The multiplicity of actors involved in the implementation of the actions—each with their own timeframes, priorities, interests and mechanisms—suggests the need to establish an organizational framework to facilitate the articulation, functionality and sustainability of the program.

In this regard, it proposes as a high priority action the development of an institutional framework and the harmonization of legal frameworks as essential tools for coordinating, scheduling, and control of the strategic actions of the program, keeping in mind the regional nature of its objectives and encouraging the participation of different local actors appointed at the national level through country representatives and at the regional level in the framework of the CIC.



Iguazu Falls on the Argentina–Brazil border.

Chapter 1: Introduction

1.1 Characteristics of the La Plata Basin

The La Plata Basin, with an area of approximately 3.1 million km², is formed by the water systems of the Paraguay, Paraná, Uruguay, and La Plata rivers, and can be subdivided into seven sub-basins: Upper Paraguay, Lower Paraguay, Upper Parana, Lower Parana, Upper Uruguay, Lower Uruguay, and the sub-basin of the La Plata River itself. Its current population exceeds 110 million people, and it includes the cities of Buenos Aires, Sucre, Brasilia, Asunción, and Montevideo, the respective capitals of the five countries that make up the Basin: Argentina, Bolivia, Brazil, Paraguay, and Uruguay. The wealth of its natural resources has attracted a large population to the Basin, which today favors its economic development.

The Basin presents an important diversity of climates, from the dry and very hot western Chaco province to the humid southern regions of Brazil and southeast Paraguay. These climates have interseasonal or interannual variability, which often results in extreme droughts or floods.

The Basin is also rich in groundwater resources. It coincides in large part with the Guarani Aquifer System (GAS), one of the largest subterranean water reservoirs in the world, while to the west is the Yrenda-Toba-Tarijeño Transboundary Aquifer System (YTTAS), which coincides mostly with the semiarid Gran Chaco Americano zone.

It also houses the largest system of river wetlands on the planet —connected in the center by the great rivers Paraguay, Parana and La Plata— and is widely recognized by the amount, variety, and endemism of species of fish. By 2015, there were 601 protected areas, 29 Ramsar Sites, and 18 Biosphere Reserves (MAB-UNESCO).

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In the center-east part of the basin lies the Selva Misionera Paranaense (SMP). In this

area, there has been a gradual loss of forest mass since the mid-twentieth century, as it has been replaced by pastures, agricultural crops, and tree plantations, leading to extraordinary degradation of the soil, changes in hydrological cycles, and local climatic fluctuations. This ecoregion is still considered a high priority for conservation.

The natural population growth in both urban and rural areas, associated with the strong growth of agricultural and industrial activities, has significantly increased the use of hydraulic resources, particularly those from underground sources, whose extraction can exceed 100,000,000 m³/year in some areas. With the growth of the cities, water supply sources are often overexploited or contaminated, which results in a health risk for the population. Agriculture is the main economic activity in the Basin. The main crops correspond with annual

cycles: soybeans, wheat, corn, and rice, the latter produced with floodwater irrigation, as it requires large amounts of water.

Industrial activity is diversified and particularly connected to the major urban centers in Argentina and Brazil, where the automotive industry and petroleum derivatives represent the principal products. The mining industry also plays an important role in the economic activities of the countries in the region.

The Basin possesses the very important capability of generating hydroelectric power—one of the largest energy resources in the world—and its exploitation represents a good portion of the energy generation in the countries that make up the Basin. Navigation is conducted on the Paraguay-Parana and Uruguay waterways below the Salto Grande dam, and on the Tietê-Parana waterways all the way to the Itaipu dam.

1.2 The integration process

In 1969, the governments of Argentina, Bolivia, Brazil, Paraguay, and Uruguay signed the La Plata Basin Treaty, the main legal instrument governing the Basin. It was through this treaty that the Intergovernmental Coordinating Committee of the Countries of the La Plata Basin (CIC) was formed as the official body to promote its objectives. The CIC was created in February 1967 during the First Meeting of Foreign Ministers of the La Plata Basin, wherein participating governments agreed to conduct a joint comprehensive study of the area with the intention of collaborating on multinational, bilateral, and national projects for the progress and development of the region.

The institutional framework for regional integration was later strengthened by the Asuncion Treaty, which created the Common Market of the South (Mercosur) in

1995, intended to encourage intraregional and international trade amongst the countries involved.

Since its inception, the CIC has focused on areas of common interest in the five countries, facilitating studies and programs in the areas of hydrology, natural resources, transportation, navigation, soil, and energy. In particular, the comprehensive study of natural resources in the La Plata Basin conducted by the OAS in the '70s was very important because it allowed for countries to gear their actions toward taking advantage of energy and transportation potential and to identify environmentally critical areas, such as the sub-basins of the Pilcomayo and Bermejo Rivers —characterized by the highest rates of erosion and sediment transport in the world— or the Upper Paraguay sub-basin (Pantanal), which is known for the value of its wetland ecosystem and its key role in water regulation in all of the La Plata Basin.



Corá Hills in Amambay, Paraguay.

1.3 The Framework Program of the La Plata Basin

During the IV Inter-American Dialogue on Water Management (Foz do Iguacu, Brazil, 2001), the countries of the La Plata Basin agreed to carry out a regional program to advance integrated management of the water resources of the Basin in relation to climate. From this initiative and within the scope of the CIC, funding was obtained from the Global Environment Facility (GEF) for the preparation and implementation of the *Framework Program for the Sustainable Management of La Plata Basin's Water Resources, with respect to the Effects of Climate Variability and Change* (Hereinafter the *Framework Program*). These activities received technical and operational support from the Department of Sustainable Development of the General Secretariat of the Organization of American States (DSD-GS / OAS), within the framework of a collaborative agreement signed by the CIC and the United Nations Environment Programme (UNEP), as the GEF implementing agency.

The principal objective of the Framework Program was to strengthen cross-border cooperation between the governments of Argentina, Bolivia, Brazil, Paraguay, and Uruguay to ensure that the shared water resources in the Basin would be managed in an integrative and sustainable way, in the context of climate variability and change, capitalizing on opportunities for development.

The Framework Program included a first draft of the formulation (2003–2005), and then a preliminary analysis of the main en-

vironmental problems and the challenges to overcome in the La Plata Basin was carried out. Through a process of broad institutional participation, the state and behavior of water systems was characterized, synthesizing the main Critical Transboundary Issues (CTIs) both current and emerging with their respective associated causal chains. Preliminary proposals were identified as well as gaps in information. Subsequently, Stage 1 of the Framework Program was carried out (2010–2016), allowing for the deepening of knowledge about various aspects of the Basin and analyzing the Transboundary Diagnostic Analysis (TDA), considering the effects of climate variability and change and formulating the Strategic Action Program (SAP) for the La Plata Basin.

The most accurate and detailed characterization of the CTIs, based on the results of the various components on which the project was organized, facilitated the design of strategies for integrated water resources management in the whole Basin. The activities were carried out with the active involvement of specialists and authorities from various government institutions and academia related to water resource management, environment, and climate in each country. An important aspect of Stage 1 of the project was the development of future climate projections in greater detail in order to identify the potential impact of climate change on different socioeconomic sectors (agriculture, energy, health, water resources, etc.)¹

The results of the climate projections provided input for the preparation of the up-

¹ A simulation with the Eta-20 kilometers regional climate model was initially performed using the initial conditions and borders of the HadGEM2-ES model (UK Met Office Hadley Centre Global Environment Model, version 2 with components of the Earth System (ES)), and the CO₂ emissions scenario of RCP 4.5. The initial conditions and outline from the Eta-20km were subsequently used to perform a simulation with the Eta-10km regional climate model, also using the HadGEM2-ES version 2, the components of the Earth System (ES - Earth system), and CO₂ emissions scenario 4.5.

dated version of the Transboundary Diagnostic Analysis (TDA), guiding the management recommendations for each of the CTIs analyzed. The results of the TDA formulation process were analyzed in national and regional meetings, and then presented and validated at the Project Steering Committee in June 2016.

The structure of the Stage 1 implementation of the Framework Program included four components and their associated strategic actions:

I. Strengthening cooperation for the integrated management of water resources with an emphasis on hydro-climatic aspects, which included: consolidation of coordination capacity, CIC planning and management and the technical and institutional capacities of the participating institutions, and the harmonization of a legal framework for the integrated management of water resources in La Plata Basin, in alignment with the vision of sustainable development that will be encouraged in foreseeable scenarios of climate variability and change. This objective of component I materialized through the following three strategic action groups:

I.1: Harmonization of legal and institutional frameworks, including strengthening the integrated management of the Basin through: i) a horizontal cooperation program between participating countries; ii) training courses for agents and technical managers in program implementation and issues related to the activities that need to be executed; and iii) a knowledge-sharing program for advanced students to collaborate with the institutions executing the program. Similarly, progress was made

in the development of conceptual legal frameworks harmonized through: i) identifying, deepening, flowcharting, and disseminating concepts, legislation, and institutional structure on hydro-environmental topics on national, regional, and international scales. And finally, through the implementation of a decision-making support system, a foundation of which was established to access, articulate, process, and integrate information related to the Basin in support of decision-making related to integrated water resource management, extreme and high-risk hydrological events, drought, and water pollution, among other things.

I.2: Public participation, education, and communication as a cross-cutting component designed to strengthen the active participation of civil society, increasing knowledge and interaction amongst organizations in the Basin and the involvement of key social actors to promote greater and better participation of civil society in the sustainable management of natural and development resources, particularly considering gender equity. An important instrument for this purpose is the Fund for Promoting Public Participation (FPPP), designed to promote the involvement of civil society organizations, municipalities, private companies, and others in critical issues affecting the Basin.

I.3: A monitoring and evaluation plan, including a follow-up plan that will be upheld by the indicators defined in the logical framework. The indicators were useful tools for monitoring, understood as a process of continuous evaluation of the progress and

achievements of the program, and for the different levels of assessment.

II. Integrated management of water resources, with an emphasis on integrated management of surface-subterranean water resources and their adaptation to climate variability and change, through the following strategic actions:

II.1: Water balance in La Plata Basin, as a support tool for resource management that includes water supply and demand assessment.

II.2: Evaluation and monitoring of the quality and quantity of water and pollution, through which the basic monitoring network for shared courses was established for monitoring the quality and quantity of physico-chemical conditions. In addition, the technical capabilities of national institutions responsible in this area were also consolidated, working under a common regional understanding under the CIC.

II.3: Integrated management of groundwater, generating preliminary guidelines for integrated management from the experiences of the Guarani Project and the implementation of the Project for managing the Yrenda-Toba-Tarijeño Aquifer System (YTTAS).

II.4: Ecosystem management, developing harmonized strategies and promoting conservation and sustainable use of biodiversity in the La Plata Basin, with particular attention to the conservation of wetland and riparian ecosystems and fish fauna.

II.5: Land degradation control, generating basic information on the soils of the Basin, identifying critical areas

and integrating actions carried out by individual projects in the region (Bermejo, Pantanal, Gran Chaco, and Pilcomayo).

II.6: Opportunities for sustainable development, taking into consideration the promotion of projects that encourage clean technologies and capturing greenhouse gases to mitigate climate change.

II.7: Executing pilot projects in order to provide local management experiences and information for the preparation of the final TDA and SAP during Stage I. Includes:

- Pilot project to control pollution and erosion in the Pilcomayo River basin (Bolivia/Argentina/Paraguay);
- Pilot project for a hydro-environmental warning system (floods and drought in the confluence area of the Paraguay and Paraná rivers—Argentina, Paraguay, and Brazil);
- Pilot project for conflict resolution over water use in the Cuareim/Quarai River basin (Brazil and Uruguay);
- Pilot project for biodiversity conservation in reservoir areas of the Parana River (Argentina, Brazil, and Paraguay).

III. Hydro-climatic prediction system in the La Plata Basin and adaptation to the hydrological effects of climate variability and change, aimed at achieving more knowledge, technical and operational capacity in the five countries of the La Plata Basin to predict, with greater se-

curity and farther in advance, the hydrological effects of climate variability and change and to consider, in particular, disaster mitigation, as well as floods and droughts and climate adaptation and hydrological regimes in the Basin.

IV. Strategic Action Program preparation, technically justified and with social consensus, which deepens the proposed framework program based on the adjustment and great detail of the Macro TDA, in the results of priority and de-

monstrative projects, and of specific complementary studies carried out during project implementation, including on navigation and hydropower.

The implementation of Stage 1 has allowed for the installation of initial integrated management capacity in the Basin under the CIC and through the joint work of national institutions from the five countries updating and enhancing the TDA and strengthening the strategic actions of the La Plata Basin SAP.



The Parana River.



Flooding due to overflows in the upper basin of the Paraguay River.

Chapter 2:

Critical Transboundary Issues

During the formulation of the Framework Program (2003-2005) and the implementation of Stage 1 (2011-2016), the following current and emerging Critical Transboundary Issues (CTI) were established in the La Plata Basin, as well as their main causes and recommendations for addressing them, as presented below:

- ***Extreme hydrological events***

Since 1970, floods in the Basin have become more frequent, occurring on average every four years. The higher frequency is associated with the El Niño phenomenon and with the impact of land use in the upper basins of the major rivers. Moreover, the majority of the rivers in the Basin have large floodplains that have been occupied both by the population and for agricultural activities. Also, in recent years, there has been an increase in the subterranean water levels in the Pampas region in Argentina associated with natural and anthropogenic causes, causing damage to underground infrastructure in urban areas and an increase in the possibility of groundwater contamination and, in rural areas, flooding in large areas intended for agricultural use.

As for drought, one can distinguish the cases where a lack or decrease in precipitation affects areas in diverse ways due to the reduced availability of water—in quality and quantity—to meet the demands for domestic and agricultural use, among other things. There are those cases where such a lack or decrease in water is reflected in reduced flows and river levels—which is sometimes known as “low water”—affecting in particular hydroelectric generation and navigation.

Among the main causes detected for this CTI, associated with extreme events, is the lack of urban and territorial planning, poor coordination of information on extreme events, and lack of regional disaster prevention policies and of education and awareness programs. In light of this, it is recommended to expand and improve coordination between the various monitoring systems on information, climate forecasting, and early warning; to consolidate information from the various monitoring systems, improve urban and regional planning to increase resilience and reduce vulnerability to extreme events; promote the development of regional policies, to strengthen legal framework for the preven-

tion and management of such events, and to exchange experiences with research programs, environmental awareness and education related to them, among other issues.

- ***Loss of water quality***

The main threats to water quality are point source pollution—a consequence of the discharge from residential and industrial sewage runoff and, in specific areas, from mining and oil production—and diffuse pollution, which is a result of agricultural activities, as well as municipal solid waste, which is discharged by drainage networks into the main river channels. In addition, sewage runoff contributes a large amount of what are now called emerging contaminants such as pharmaceutical drugs that are ingested daily by the population and whose metabolites are eventually flushed into surface water bodies by sanitation networks, representing a threat to aquatic ecosystems.

For this CTI, the main causes detected are: inadequate sewage treatment, lack of training for environmental managers, lack of development policies that encourage the use of clean technologies and minimization of waste, and deficiency of compliance with existing regulations.

For mitigation it is recommended primarily to seek funding for the construction and operation of domestic and industrial wastewater treatment plants, to promote the implementation of sustainable agricultural practices and the rational use of agrochemicals, and to develop training programs for environmental managers.

- ***Sedimentation of waterways and bodies of water***

The sedimentation process alters and jeopardizes the structure and operation of eco-

systems and thus, the environmental goods and functions they provide. The highest specific verified production of sediment is in the Andean section of the Basin, as the most notable sources are the upper basins of the Bermejo and Pilcomayo. In the rest of the basin, erosion and sedimentation problems resulting from agricultural activities also deserve special consideration because they generate productivity loss and deterioration of structure and porous space.

The principal causes of this issue have been identified as improper use and handling of soil (farming expansion, use of marginal soils, elimination of natural pastures, overgrazing); the lack of incentives, expansion policies, and training to implement sustainable agricultural techniques; and technical and economic weakness of state agencies. For this, it is recommended to promote the development and harmonization of standards for the protection and use of natural resources; to implement agro-ecological zoning and land use plans; to strengthen institutional capacity for land use management; to implement soil recovery and erosion control programs in priority areas; and to develop training and expansion management programs in management techniques and soil conservation.

- ***Disruption and loss of biodiversity***

There is great concern about the threat to the integrity of the Basin ecosystem due to the progress of anthropogenic activities. The work that has been carried out has allowed for the identification of the loss or alteration of habitats and the fragmentation and loss of connectivity, which can be aggravated by the effects of climate change in those areas most vulnerable to the rise in groundwater levels, the loss of integrity (goods and services) due to environmental risk, with impacts on biodiversity in the

entire Basin, mainly in the Pantanal and the Selva Misionera Paranaense. Meanwhile, the dams have affected some floodplains and interrupted migratory corridors. Bivalve mollusks of the *Corbicula* genus and the golden mussel (*Limnoperna fortunei*) are some of the invasive species that demand the most attention for their remarkable distribution throughout the Basin and their proven impacts on native wildlife, the ecosystem, infrastructure works (such as water outlets), and other human activities.

The main causes identified for this CTI were the replacement of natural ecosystems with productive activities; the lack of incentives for the care and conservation of natural systems; the lack of protocol for the control of invasive species; and the lack of social awareness around the value of water resources and biodiversity. Given these causes, it is recommended to establish cooperation mechanisms between countries regarding biodiversity; to develop ecological corridors in the rivers and coasts and other forms of conservation that contemplate social participation; to promote the development of transboundary protected areas and the adoption of regional minimum standards for biodiversity conservation.

- ***Unsustainable use of fishery resources***

Unsustainable use of fishery resources alters the structure and operation of aquatic communities and can seriously compromise them. In any of the seven sub-basins, 53% of fish species are considered endemic, indicating that biodiversity conservation of fish requires varied efforts. There have been 13 exotic species of fish registered in the Basin, several of which are invasive. There is a high risk of an increase in invasive alien species that escape from their farms. In some areas, the retraction of fishable stocks due to the effects of high-pres-

sure fishing have been proven. The low level of protection and the loss of terrestrial habitats impact fish biodiversity.

The main causes of this CTI appear to be overexploitation of species for commercial interests; lack of technical consistency and design and implementation of fisheries policy; the lack of harmonious and integrated policy for the protection of aquatic life in the whole Basin; and unsustainable practices and difficulties in accepting new technologies. For recommendations, it is especially suggested to promote integrated policies, standards, and criteria for the protection and sustainable use of fishery resources at the basin level; to strengthen tools and management and control mechanisms; to conduct vulnerability studies on priority riparian habitats; and to implement awareness and training programs on sustainable production techniques.

- ***Unsustainable use of aquifers in critical areas***

This is regionally seen as an increase in the use of subterranean water resources due to urban and rural population development and a sharp increase in agricultural and industrial activities in the subterranean water, such as the lack of knowledge on the vulnerability of recharge areas and deficiency in well levels and monitoring their exploitation.

The major causes of this CTI have been identified as pollutants from agriculture and domiciliary and industrial waste; lack of management over the use of groundwater; lack of transboundary institutional coordination for shared control and management; and the limited social participation. The main recommendations to improve these conditions include developing tools for integrated and participatory management;

performing vulnerability studies to identify high-risk areas at the regional and local levels; developing regional data banks; and encouraging greater social participation.

- ***Water use conflicts and the environmental impact of irrigated crops***

The main reason for these conflicts lies in the continued and sustained growth of irrigated areas in the Basin. The growth in irrigated land has accelerated in the last three decades due to commercial production that is increasingly technological, and because of the persistent occurrence of droughts and the likely impact of climate change, just as the need to ensure the economic performance and survival of the businesses and agricultural producers in the area. This irrigation expansion has caused a growing conflict and demonstrates a lack of overall vision and ability to create participatory processes with stakeholders that would achieve a balanced resolution, that is, the need to implement an Integrated Water Resource Management (IWRM) program.

The main causes identified for this CTI are weak or deficient information available on shared water resources (inventory of availability and use); the lack of joint management bodies for shared water resources; asymmetries in juridical-institutional structures for integrated management of shared resources; and the ignorance of social actors as to resource value and limited availability. As for the recommendations, the main ones are to promote agreements and develop universal legal frameworks for water use management; to strengthen management capacity and institutional coordination within competent bodies the five countries; to generate information and facilitate public access to the data of interest for supply and demand management; and to establish communication, dissemi-

nation, and awareness-building strategies around management.

- ***Lack of disaster contingency plans***

The Basin's rivers and its riparian areas are subject to the risk of disasters due to extreme natural events and human error, which can cause various kinds of accidents, such as toxic substance spills and broken infrastructure. Accidents and disasters already registered in the Basin have highlighted the lack of prevention plans and, above all, accident contingency plans. The countries face these situations with isolated measures, often untimely and insufficient and subject to a plurality of jurisdictions. Hence, the need to prepare to prevent or face such events in a coordinated fashion.

The major causes of this CTI have been identified as the risks associated with the operation of dams; the lack of updates to dam safety criteria taking the impacts of climate change into consideration; the absence of national and transnational regulations governing dam safety and lack of awareness about the risks for populations located downstream of such works, as well as the operating companies themselves. Therefore, the main recommendations are: to establish common standards and safety criteria, taking into account the impact of climate variability and change; to develop and adopt national regulations and transnational safety agreements and emergency operation plans; to develop or update contingency plans and programs in the event of broken dams; and to develop citizen awareness measures on prevention risk reduction.

- ***Poor water health and deteriorating environmental health***

This is a problem that primarily involves urban areas —residential and industrial

pollution source points— and agricultural and mining activities. There is a serious situation in urban and rural settlements in the Basin caused by biological contamination from the lack of sanitation facilities and adequate wastewater treatment services. Incidents of waterborne disease are common in certain regions, particularly in those where there are homes without access to clean drinking water or sanitation services. Regarding the potential health risks in drinking water sources, in recent years there have been a number of blue-green algae blooms or toxigenic cyanobacteria that have successfully colonized aquatic ecosystems and are currently dispersed in inland water bodies (rivers, lakes, reservoirs) and marine environments.

The principal causes of this CTI have been identified as the lack of information on waterborne diseases; inefficient control over industrial rollovers and application of agrochemicals in agriculture; the asymmetry of the legal and technical criteria and for water resource and public health management; and resistance to making changes in habits. As recommendations, it emphasizes strengthening research and the generation and dissemination of data on waterborne disease; promoting policies and programs for treating municipal solid waste, industrial waste, and management of agrochemicals; strengthening the capacity of local managers and the institutional articulation and coordination of organizations and institutions in the water and sanitation sectors in each country; and encouraging education and citizen awareness programs on environmental hygiene and health.

- ***Navigational limitations***

Navigation is one of the fundamental socioeconomic sectors for integrating the Basin by providing connections between pro-

duction centers, storage, and ports from which products are exported to rest of the world. Currently navigation is mainly dedicated to transporting products, primarily agricultural products, between the different regions of the Basin. Whether it is the most economical means of transport depends on the connections with other factors—the impulse to develop ports, investment in the maintenance roads and ports, and agreements among countries. Integrated assessment of all elements within the country institutions associated with economic potential it is the great challenge for the expansion and modernization of navigation in the Basin.

The main causes for this CTI are considered to be lack or inadequacy of infrastructure to overcome natural critical points, weak joint institutional management, and asymmetries in country regulations. Given this, it is recommended to fundamentally strengthen relations between the countries of the La Plata Basin and harmonize regional policies for river transport; to adapt the legal and institutional framework for inland navigation; to develop cross-border plans for maintenance and dredging of navigable waterways; and to promote an integrated transportation system.

- ***Limited development of hydroelectric potential***

Hydroelectric generation is another core activity for socioeconomic integration in the Basin, which has a high concentration of this type of energy generation in all of the countries. In the energy matrix, hydropower is the main form of energy in at least three of the basin countries —Brazil, Paraguay, and Uruguay— and it is also important for Argentina. An important part of the power associated with this energy form is in border sections. Hydroelec-

tric production provides opportunities for synergy between countries in its generation and dissemination.

For this topic, a causal chain analysis was not performed, but advances made during this stage may be noted as recommendations: creating energy integration agree-

ments between Basin countries; integrating hydro-meteorological monitoring of hydraulic exploitation networks with other information systems; and taking actions to use the regional interconnected communications system to improve the transmission of regional information for early-warning hydrological systems.



Piracema Canal en Itaipu.



Chapter 3: Conceptual Foundation of the Strategic Action Program

3.1 Vision and objectives

After the process of updating the TDA and putting forth its respective recommendations, the following vision and objectives for the SAP, as well as the associated goals for each CTI, of the La Plata Basin was created. The process involved the consolidation and prioritization of recommenda-

tions based on causal analysis, defining objectives to achieve qualitative goals for each CTI, and identifying the main corresponding actions, defining in general terms the position, structure, and content of the SAP. **Table 1** shows the goals and objectives for each CTI.

Vision:

The countries of the La Plata Basin, strengthened by the shared management of water resources, achieve sustainable development and the welfare of their inhabitants, overcoming critical transboundary issues and in consideration of the effects of climate variability and change.

SAP objective:

To promote the management of shared water resources, cooperation and regional integration, while seeking to achieve sustainable development in the La Plata Basin countries and the welfare of their inhabitants.

Table 1

Goals, objectives and management recommendations for Critical Transboundary Issues in the La Plata Basin

Critical Transboundary Issue / Associated Goals	Objectives / Recommendations for the SAP
<p>Goal 1.</p> <p>Less impact and vulnerability to extreme hydrological events</p>	<ul style="list-style-type: none"> • To promote the development of policies and the strengthening of legal frameworks for the prevention and management of extreme events. • To strengthen hydro meteorological monitoring and prediction systems. • To promote institutional cooperation and coordination throughout the Basin. • To improve urban and regional planning to increase resilience and reduce vulnerability to extreme events. • To strengthen national and local agencies in managing extreme events. • To develop research programs, awareness, and environmental education.
<p>Goal 2.</p> <p>Reduce pollution levels and maintain water quality in a sustainable way</p>	<ul style="list-style-type: none"> • To harmonize and consolidate standards and measuring and control instruments. • To promote solid waste management and domestic wastewater treatment. • To reduce nutrient inputs and agricultural and industrial pollutants to water bodies. • To strengthen institutional capacities and collective monitoring at the Basin level. • To develop training and citizen participation programs
<p>Goal 3.</p> <p>Reverse processes of land degradation; less sedimentation of water bodies and waterways</p>	<ul style="list-style-type: none"> • To promote the development and harmonization of natural resource use and protection standards. • To strengthen institutional capacities for land use management. • To implement land remediation and erosion control programs in priority areas. • To develop training and extension programs in land use and management.
<p>Goal 4.</p> <p>Utilize aquifers sustainably, while meeting development needs</p>	<ul style="list-style-type: none"> • To promote the development of a policy and regulatory framework for sustainable aquifer use. • To strengthen management capacity and institutional coordination. • To promote research and exchange of information. • To implement education and awareness programs.

**Critical Transboundary Issue /
Associated Goals**

Objectives / Recommendations for the SAP

Goal 5.

**Rational and sustainable use
of fishery resources**

- To promote compatible protocol and criteria for the protection and sustainable use of fishery resources at the basin level.
- To strengthen tools and mechanisms for management and control.
- To develop actions to prevent and reverse the reduction of fishable stock.
- To implement awareness and training programs in sustainable production techniques.

Goal 6.

**Greater connectivity
and integrity of river
and coastal ecosystems,
reducing environmental
risks and impacts on aquatic
biodiversity**

- To strengthen and harmonize regional legal frameworks for the protection of aquatic biodiversity.
- To strengthen the management capacities of competent organizations.
- To develop river and coastal ecological corridors and other forms of participatory conservation.
- To integrate information, research, and monitoring systems at the Basin level.
- To implement awareness-building programs and training.

Goal 7.

**An increase and regulation
of water supply and
improved irrigation
efficiency, reducing tensions
and the potential impacts of
irrigated crops**

- To promote agreements and the development of common legal frameworks for managing water use and audit systems.
- To develop measures to increase water capture and storage, and to improve irrigation efficiency.
- To strengthen the management capacities and institutional coordination of competent organizations.
- To generate information and facilitate public access to data of interest for supply and demand management.

Goal 8.

**Potential disaster impacts
are reduced due to dam
operation**

- To promote the development of common standards and criteria for dam safety, considering the impact of climate variability and change.
- To promote the exchange of information and experiences on security of public works and dam operations.
- To develop/update contingency plans and programs.
- To develop public awareness-building measures concerning prevention and risk mitigation.

Goals, objectives and management recommendations for Critical Transboundary Issues in the La Plata Basin (cont.)

Critical Transboundary Issue/ Associated Goals	Objectives / Recommendations for the SAP
<p>Goal 9.</p> <p>Environmental sanitation in cities reduces water contamination and the incidence of disease</p>	<ul style="list-style-type: none"> • To promote policies and programs for solid and industrial waste treatment and agrochemical management. • To strengthen the capacity of local managers and institutional coordination. • To strengthen research and the generation and dissemination of data on waterborne diseases. • To implement citizen education and awareness programs on environmental hygiene and health.
<p>Goal 10.</p> <p>River navigation is enhanced as a transportation and a regional integration tool</p>	<ul style="list-style-type: none"> • To promote policy development and to strengthen standards for river transport. • To promote structural improvements for maintenance and port operations. • To strengthen institutional capacities for planning and joint management.
<p>Goal 11.</p> <p>Energy integration increases the reliability of systems</p>	<ul style="list-style-type: none"> • To strengthen institutional coordination and exchange of information and experiences with hydropower. • To promote multiple uses of shared reservoirs and the use of bonuses in integrated water resource management. • To articulate hydro meteorological monitoring systems in energy planning.
<p>Goal 12.</p> <p>Greater resilience and adaptive capacity reduces risks and impacts related to climate variability and change</p>	<ul style="list-style-type: none"> • To promote the incorporation of climate change measures in policies, strategies, and development plans.

3.2 Consolidation of Recommendations and Definition of the SAP Structure

Recommendations for each of the goals, both in terms of objectives and actions, were initially grouped according to the nature of the proposed intervention. This first grouping consolidated the politico-institutional, socio-cultural, and economic-managerial aspects associated with different goals, added together with gaps in information.

The recommendations based on the CTIs and grouped by the various aspects were subsequently consolidated into six (6) strategic areas (Figure 1), according to the following approach:

- I. **Information management:** Incorporates actions related to searching, identifying, integrating, processing, and disseminating the information needed to support decision-making in integrated water resource management in the context of climate variability and change, including early detection systems and hydro-environmental monitoring.
- II. **Planning, management, and sustainable use of water resources:** Includes planning and management actions aimed at strengthening prevention and CTI control mechanisms affecting the Basin, seeking to take advantage of potential water resources to improve the quality of life of the population within the framework of climate variability and change, and also seeking to strengthen the objective to integrate the Basin countries through actions related to the development and sustainability of potential water energy and transport.

Figure 1

Consolidation of CTI recommendations and SAP design



III. Environmental protection / rehabilitation:

Lays out a vision for correcting environmental liabilities and maintaining still-preserved areas of environmental interest; for cross-border environmental protection in the La Plata Basin through joint actions between the countries, both for the protection of still-preserved or relatively well preserved environments and for the recovery and rehabilitation of environments impacted by human action and aggravated by climate variability and change.

IV. Education, communication, and public participation:

Incorporates education, training, communication, and public participation in the Basin to improve social capacity to address/solve the CTIs and to seize participatory development opportunities in the La Plata Basin.

V. Research and Technological Development:

Actions aimed at strengthening technical and scientific development on issues of interest to resolving the CTIs and development opportunities in the La Plata Basin.

VI. Institutional strengthening:

Includes proposals aimed at promoting / strengthening the institutional and legal order necessary to address the CTIs and facilitate SAP implementation. Includes strengthening the CIC and participating national agencies acting on water resources and related areas, as well as harmonizing legal standards in developing common or compatible protocols for implementing the strategic actions and SAP activities.

Strategic area I – *Information management* precedes the others, as it adds together all of the information necessary for analysis and decision-making.

The nucleus of the SAP is made up of two strategic areas: II – *Planning, management, and sustainable use of water resources* and III – *Environmental protection/rehabilitation*.

The first is more oriented toward the future, organizing water management in the context of sustainable development. The perspective of the second is to preventatively remedy environmental liabilities and to prevent further environmental degradation, depending on the use and management of water and land resources, within the framework of climate variability and change.

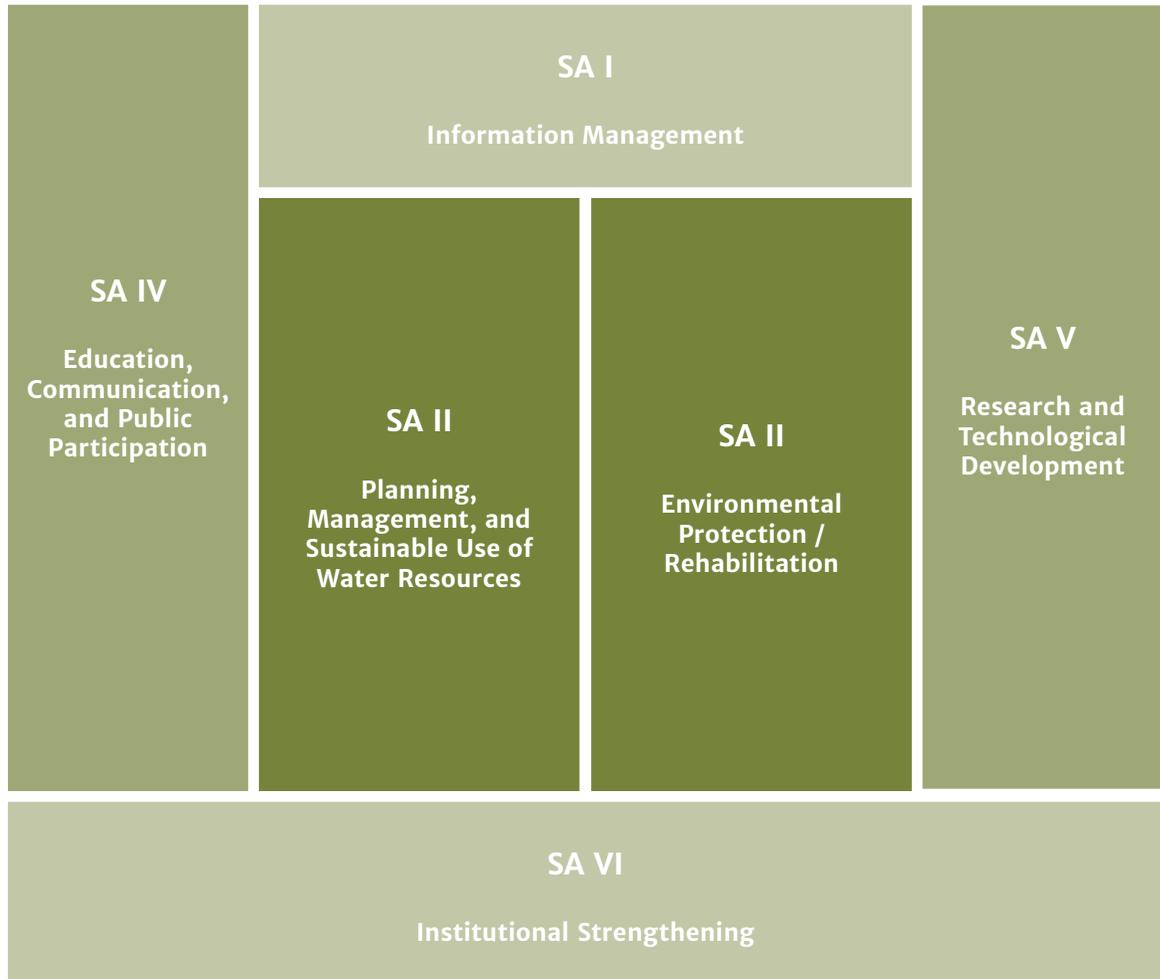
Two transverse areas were also formulated: strategic area IV – *Education, communication, and public participation* and strategic area V – *Research and technological development*.

The first aims to deepen ties with society and public participation, with a goal of creating action items around education aimed at training on critical issues for the development of La Plata Basin. The second aims to deepen knowledge about the processes involved, reducing information gaps and developing new technologies in the interest of solving the CTIs.

Finally, the strategic area VI – *Institutional strengthening* aims to support all SAP activities through the development and strengthening of the institutional frameworks necessary for the implementation of the program.

Figure 2

Correlation between the proposed strategic areas for the SAP





Port of Montevideo, Uruguay.

Chapter 4: Strategic Areas, Components, and Strategic Actions and Activities of the SAP

La Plata River Basin's Strategic Action Plan (SAP) has a time frame of 20 years, and includes six (6) strategic areas, 13 components, and 28 strategic actions. The combination of these actions and the 130 activities that comprise these actions constitutes the intervention response and management recommendations aimed at resolving or mitigating the impacts of the main Critical Transboundary Issues (CTI) that affect the basin, and serve as a foundation for an-

alyzing the identified causes, promoting sustainable development. While the environmental, social, and economic impacts of each one of these actions can be differentiated, all are considered priority actions, to the extent that they address topics of particular importance to the area or to the region and/or to advance the resolution of critical issues related to the Basin in general. The structure of the SAP is presented in **Table 2**.



Selva Misionera Paranaense.

Table 2

SAP Structure (strategic areas, components, and strategic actions)

Strategic area / component	Strategic actions
STRATEGIC AREA I: INFORMATION MANAGEMENT — DSS for IWRM in the La Plata River Basin	
I.1 Networks and Information Systems	I.1.1 Expansion and consolidation of monitoring networks I.1.2 Expansion and integration of information systems
I.2 Hydro-environmental Monitoring and Hydrological Warning	I.2.1 Design and implementation of a hydro-environmental monitoring system in the La Plata Basin I.2.2 Consolidation of the hydrological alert system for La Plata Basin
STRATEGIC AREA II: PLANNING, MANAGEMENT, AND SUSTAINABLE USE OF WATER RESOURCES	
II.1 Integrated Water Resource Management and Adaptive Measures	II.1.1 Integrated management of surface water and groundwater in critical areas II.1.2 Land use planning and restructuring in priority vulnerable areas II.1.3 Water supply management program II.1.4 Risk management and adaptive measures program
II.2 Sustainable Productive Development	II.2.1 Promote farming systems resilient to climate variability and change II.2.2 Sustainable fishery and aquaculture programs II.2.3 Ecotourism program II.2.4 Clean technology program
II.3 Water Resource Use in the Context of Regional Integration	II.3.1 Enhance river navigation as a mode of transportation and regional integration II.3.2 Coordinating hydroelectric systems in the context of climate variability and change
STRATEGIC AREA III: ENVIRONMENTAL PROTECTION/ REHABILITATION	
III.1 Ecosystem Management	III.1.1 Conservation and expansion of protected areas and sustainable management of riparian and wetland ecosystems III.1.2 Management of aquatic and other associated ecosystems
III.1.2 Sustainable Land Management	III.2.1 Land recovery and erosion control III.2.2 Local conservation and sustainable land management
III.3 Environmental Sanitation	III.3.1 Reduction of pollution sources III.3.2 Urban sanitation and health

Strategic area / component Strategic actions

STRATEGIC AREA IV: EDUCATION, COMMUNICATION, AND PUBLIC PARTICIPATION

IV.1 Environmental Education IV.1.1 Environmental education program
 IV.1.2 Training and rural outreach program

IV.2 Communication and Public Participation IV.2.1 Social communication and public participation program to promote awareness and social participation

STRATEGIC AREA V: RESEARCH AND TECHNOLOGICAL DEVELOPMENT

V.1 Research and Technological Development V.1.1 Support research development, technological development, and innovation associated with the CTIs

STRATEGIC AREA VI: INSTITUTIONAL STRENGTHENING

VI.1 Institutional Framework VI.1.1 Strengthening of CIC as an organization for coordination and institutional linking for the purpose of SAP implementation
 VI.1.2 Strengthening national agencies in the SAP implementation stage

VI.2 Legal Framework VI.2.1 Harmonization of national legal frameworks for transboundary water resource management, including agreements between countries
 VI.2.2 Developing common technical guidelines and protocols for actions aimed at enabling the management of shared hydraulic resources

**STRATEGIC AREA I.
INFORMATION MANAGEMENT –
Support system for decision-making
in the field of integrated water
resource management (IWRM) of
La Plata Basin**

Strategic area I seeks to establish as an objective a common baseline for the coordination, processing, integration, and access to information relative to the diverse aspects of the Basin, such as supporting decision-making related to the integrated management of hydraulic resources, in the context of climate variability and change.

With this aim, the Decision-making Support System for La Plata Basin (DSS-Plata) will be put in effect. The management of the information generated by DSS-Plata will be done through an operating tool, which will enable the CIC to coordinate and communicate the information from the competent bodies of the 5 countries, with the objective of addressing the Critical Transboundary Issues, within the context of climate variability and change. The actions included under this strategic area seek to advance and strengthen the efforts made during the implementation of the Framework Program (2011-2016).

During the Framework Program, a hardware system was established to serve as the base for DSS-Plata, which is comprised of nodes located in the 5 countries that form the Basin and in the CIC, the coordinating body of all of the actions realized by countries under the framework of the La Plata River Basin Treaty. It consists of a free-access online information platform containing information relative to hydraulic resources and the environment generated by the supervisory institutions of the countries and other regional and supra regional authorities. This platform will allow access to georeferenced information through a map viewer and access to historic registries of hydro meteorological variables. It also features a base map of the La Plata Basin, as well as information on groundwater and ecosystems, among other things. Additionally, it provides a virtual space through which to integrate information generated by other projects previously developed in the region through initiatives such as WIGOS and WMO.

In the future, it seeks to expand the hydro meteorological information base, to incorporate a catalog of legislation and policy guidelines on shared management of hydraulic resources, and to facilitate the



Dawn in the Basin.

tasks of processing and operations analysis, either through hydro environmental monitoring or a hydrological alert system. The development of DSS-Plata will be accompanied by institutional strengthening of the bodies responsible for generating and managing information in accordance with international standards, as outlined in strategic area VI.

This strategic area about information management consists of the first planning component I.1 Networks and Information Systems, which integrates strategic actions associated with observation networks and with information systems, such as thematic mapping for management purposes; and component I.2 Hydro-environmental monitoring and hydrological warning, which considers the operational tasks associated with the LPB's hydro-environmental monitoring and hydrological alert systems.

Component I.1 Networks and Information Systems

This component is associated with the planning process and seeks as its objective to expand, consolidate, and integrate necessary information to strengthen knowledge of hydro meteorological and hydro-environmental phenomena, taking into consideration the networks and systems already developed within the five countries.

In accordance with the TDA studies, the La Plata Basin has a network for monitoring hydraulic parameters and water quality with marked asymmetry, with respect to both qualitative and quantitative aspects. The number of stations, their characteristics, distribution, and density of the network present characteristics/degrees of development differentiated in each country. In general, a significant number of stations are observed, principally in terms of rain-

fall and hydrometric measurements, with a series of registries reflecting varying longitude, which will allow for the evaluation of resource availability and multipurpose use planning. Nevertheless, when these networks are considered at the sub-basin level, significant differences are observed. For example, the sub-basins of Paraná possess the network with the best characteristics, meanwhile the networks of the Uruguay River and the Paraguay River present the greatest deficiencies. The hydrometric and rainfall stations always take into account the depth of the water and eventually measure the flow of liquids and solids. It is important to highlight that various stations within these networks are not active. Data on sediment transport is relatively scarce, which is the data essential to validating and measuring the predictive models, principally in basins with a prevalence of erosion.

There are also global/regional initiatives of reference, oriented towards the development of environmental information systems. WIGOS is an integrated proposal to improve and develop the observation system of the WMO. It promotes the systematic evolution of the current observation systems (GOS, GAW, WHYCOS), operated by their member countries, towards an integrated and coordinated observation system. This will meet the observation requirements of the members of the WMO in a sustainable way, improving the coordination of the observation systems with associated international organizations. WIGOS, supported by the WMO information system (WIS), will provide reliable and timely observations and products related to climate, water, and environment for all members and programs.

The authorities of the meteorological and hydrological management bodies of the Basin agreed during the Sixteenth Session of the Regional Association III, WMO (Asuncion,

September 2014) to develop the WIGO-SAS/LPB program in the LPB, whose principal objective is “to create a homogeneous hydro-meteorological network in the south of South America, in which the five countries of the Basin and their respective meteorological and hydrological services participate, as well as organisms that deal with hydraulic matters, the CIC, and the WMO.”

One of WIGOS-SAS/LPB’s objectives is to adapt the existing networks, optimize their distribution, expand the radar network, introduce common quality control processes, and exchange best practices regarding analysis.

The possibility of expanding and interconnecting meteorological radar networks in La Plata Basin entails enormous benefits in terms of improving hydro-meteorological alert systems at the regional level. Likewise, it is important to promote the development of individual geostationary satellites for hydro-meteorological applications.

With respect to regional information systems, the Mercosur Information System (SIAM), the FAO’s land mapping, and UNESCO’s ISARM Americas information regarding transboundary aquifers represent valuable resources. Other projects that can provide a frame of reference are those being carried out in the Bermejo River Basin, the Guaraní Aquifer, the Pilcomayo River Basin, the Pantanal region, the Gran Chaco Americano region, and the La Plata River waterfront.

The strategic actions considered are:

***Strategic action I.1.1
Expansion and consolidation of monitoring networks***

This strategic action aims to promote the expansion and consolidation of observa-

tion networks, including hydrological, climatological, hydro-meteorological, water quality, sediment transport, and aquifer-level observation stations, among others. This information is an initial link for the information systems as well as the monitoring and alert systems of the La Plata Basin’s IWRM.

Taking into account a DSS installed and operating in the CIC and the five nodes in the countries, the proposed activities under this strategic category include:

- Expansion and integration of centralized access to national data networks from climatological and hydro-meteorological stations that integrate the La Plata Basin’s DSS, advancing joint work with the WIGOS-SAS projects. This includes the development of common standardization protocols for data compilation, processing, and storage.
- Integration of transboundary aquifers and water quality and quantity observation networks, defining and/or consolidating parameters.
- Expansion of surface and groundwater quantity and quality observation networks (physiochemical and biological aspects) in the La Plata Basin, promoting the incorporation of other topics of interest like erosion processes (bathymetry), invasive exotic species, and soil usage and current coverage, among others (including equipment).
- Expansion of the La Plata Basin network of meteorological radar and their interconnection, as well as the promotion and development of geostationary satellites specifically for hydro-meteorological applications.

Strategic action I.1.2
Expansion and integration of information systems

This strategic action is aimed at promoting the expansion and integration of digital mapping and library databases regarding studies, macro- and micro-regional and territorial plans, and water resource plans. This information, together with the data collected in I.1.1, is the initial link for the monitoring and alert system of La Plata Basin's IWRM.

In the current DSS-Plata, the available information includes a base map, soil characterization, and land use and coverage analysis, among other things.

The proposed activities under this strategic action include:

- Updating (in accordance with agreed upon protocol for the five countries) and expanding available cartographic information in DSS-Plata, promoting exchange and coordination among the responsible bodies from each country.
- Expansion of the DSS-Plata's digital library of studies, macro- and micro-regional and territorial plans, hydraulic resource plans, and catalog of legislation and legal frameworks regarding the shared management of hydraulic resources, among other topics.

Component I.2
Hydro-environmental monitoring and hydrological warning

This component is the operating part of La Plata Basin's decision-making support system (DSS-Plata) and seeks to design and implement the LPB's hydro-environmental monitoring system, as well as to con-

solidate the critical hydro-meteorological event alert system.

This operating part of DSS-Plata should be based on the previously existing analog systems in the countries and tasked with organizing, integrating, and consolidating information in the territorial projections in the LPB. The evaluation and quantification of the effects of climate variability and change require special attention.

The DSS-Plata will be the computational system through which information will be processed using specialized mathematical models, which will serve to support decision-making during the processes of planning, management, use, and operation of complex systems. In the area of hydraulic resources, these specialized mathematical models include rainwater to flow transformation models in natural or modified environments. For example, they consider changes to vegetation cover due to urbanization. Additionally, the models of hydro-dynamic flow propagation can include interferences in the natural drainage network and the altered drainage network due to dams, dikes, or other hydraulic constructions. Likewise, water quality simulation models can be incorporated that consider variations in concentration of diverse qualitative parameters: biochemical oxygen demand, dissolved oxygen, thermos-tolerant coliforms, etc. These DSS specialized in hydraulic resources allow for the planning of the occupation of the basin and the management and operation of its hydraulic constructions, through simulations that present the hydraulic consequences of the decisions made, taking into consideration quantitative (alteration of flow regimes) and qualitative (alteration of water quality) factors, among others.

But a DSS is not only the sum of various mathematical models. It should also pos-

sess an interface that facilitates its use by specialized staff. It should be composed of two components: the input interface, the means by which the information is entered from the simulation models utilized; and the output interface, the means by which the results are presented in an original and analytic way. This last interface includes the generation of maps that illustrate in a graphic manner the results of the simulations, graphics that superimpose calculated and observed flows, among other elements that allow for the evaluation and understanding of the results. In addition to these interfaces, the capability of converting the information generated should also exist. For example, the flows generated in the rainfall model can be automatically introduced in the hydrodynamic flow propagation model used to generate flood zones, or in the water quality module.

There are various examples of generic DSS that can be applied to any basin and/or sub-basin². For hydro-environmental monitoring, it will be necessary to develop a quality model, which could, among others, be the SAD-IPH³ model already implemented in the Cuareim/Quarai Basin as part of the Framework Program (2011-2016). For the hydrological modelling of La Plata Basin as a whole, the first phase of the MGB/IPH model was also implemented by the Framework Program. However, with respect to hydro-meteorological warning, various operating systems exist in the countries, which should be integrated and strengthened within the risk management framework, in terms of water quantity and/or quality.

The strategic actions considered are:

Strategic action I.2.1

Design and implementation of a hydro-environmental monitoring system in the La Plata Basin

Hydro-environmental monitoring aims to be a tool that provides information for decision-making regarding pollution risks and the risk of disruption of ecosystems, among other things, with the goal of promoting the implementation of control and mitigation measures for ecological and environmental risk.

This strategic action should be carried out during a planning phase and an implementation phase. In the planning phase, the transboundary areas of interest and respective variables to be monitored should be selected, based on what is developed within the subcomponents of the project, for which, in some cases, the aforementioned variables have already been established, taking into consideration the demands presented in the TDA and others that are approved during the first phase. Taking into account these variables, the second phase should evaluate the hydro-environmental planning and monitoring subsystems of the countries that can offer information relevant to the critical basins identified. The third phase will consider a proposal to coordinate and integrate information on the variables to be considered-generated by the systems of the respective countries —and the enhancement of this information, taking into consideration planning, monitor-

² Many well-known models have been developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers: <http://www.hec.usace.army.mil/>. One of the models being developed for the La Plata Basin is the Large Basin Model of the Hydraulic Research Institute at UFRGS— MGB/IPH. Information available at: <https://www.ufrgs.br/hge/projetos/projetos-em-andamento/modela-gem-Cuenca-do-Plata/>

³ This model is described at: <http://www.ufrgs.br/hge/modelos-e-outros-productos/sad-iph/>

ing, and alert purposes. The fourth and final phase will develop the proposal in a detailed manner, describing the functioning of each sub-system that comprises DSS-Plata, based on the following questions: i) which variable is being monitored?; ii) where does the information come from?; iii) how is the aforementioned information processed?; iv) what forms of integration and coordination are proposed?; v) which information enhancement options are proposed, using the resources of each country?, and iv) how is the information disseminated? Additionally, DSS-Plata operation alternatives should be identified, preferably through the coordinated participation of national organisms that operate similar systems.

During the implementation phase of DSS-Plata, the computer systems that process the information and generate the results to be disseminated should be developed. These systems should be implemented within the national bodies selected to operate DSS-Plata, including training the responsible parties. The work stations of the DSS nodes that have been available since June 2016 can be considered.

Both the strategic actions of the networks (I.1.1) and the information systems (I.1.2) will be the integration links between the data generated at the national and trans-boundary levels, which later will be utilized for hydro-environmental monitoring, where national bodies will have a space for common action.

The proposed activities under this strategic action include:

- Design and implementation of a hydro-environmental monitoring system of common interest at the La Plata Basin level. Implementation of hydro-environmental monitoring, with operating

detail in the critical basins and sub-basins and at the regional level.

- Coordination and integration of the monitoring of identified variables—generated by the country systems—and complementary information, taking into account planning and alert objectives at the La Plata Basin level.

Strategic action I.2.2 Consolidation of the hydrological alert system for the La Plata Basin

The critical hydro-meteorological event alert system will offer information to support decision-making regarding floods, droughts, navigation, hydroelectricity, and livestock farming, through agrometeorological diagnostics that will influence the development of activities associated with food security.

Hydroclimatic alert and prediction systems currently exist in the five countries of La Plata Basin, interconnected at the regional level.

The Regional Climate Center for Southern South America (CRC-SAS) —a virtual organization constructed in the form of a network in accordance with the principles defined by the WMO— is currently in its initial implementation phase and offers climate services in support of national meteorological and hydrological services.

The activities proposed under this strategic action include:

- Optimization, integration, and interconnection of existing alert systems (at the national and regional levels) in the area of DSS-Plata. Consideration of systems of support for integral risk management by sub-basins (operated at the country/state/province level) in the CIC jurisdiction.

- Coordination among diverse monitoring, information, climate prediction, and weather alert systems, in particular, strengthening and coordination of the hydraulic resource management bodies, together with the meteorological and geological services of the countries of La Plata Basin.
- Improvement of urban and territorial planning to enhance resilience and reduce vulnerability to extreme events.
- Agro-ecological zoning to reduce the impact of extreme events.
- Development of regional policy and strengthening of legal framework to improve prevention and management of extreme events.
- Development and application at the sectoral and sub-basin levels of methodologies related to the quantification of economic damages caused by extreme events.
- Expansion of the qualitative and quantitative aspects of DSS-Plata for IWRM, for use in navigation, hydroenergy, and agrometeorological prognostics. Imple-

mentation of hydrological models at the basin and/or sub-basin levels, integrated as permanently part of DSS-Plata.

- Replication and expansion of the Paraguay-Paraná and Cuareim/Quaraí Confluence Pilot Projects for risk management.
- Implementation of weather alert systems in transboundary areas.

STRATEGIC AREA II. PLANNING, MANAGEMENT, AND SUSTAINABLE USE OF WATER RESOURCES

This strategic area aims to develop and strengthen diverse topics that coincide with the integrated planning and management of the Basin's water resources, seeking to strengthen prevention and control mechanisms for the primary environmental degradation phenomena, reducing vulnerability and increasing resilience to extreme events, particularly floods and droughts. This strategic area also includes actions aimed at improving the quality of life of the population through sustainable development and maximization of available hydraulic resources in the Basin in a



Bird at Defensores del Chaco Park.

Table 3

Strategic area I — Components—Strategic actions—Activities

Strategic area I: Information Management—DSS for La Plata Basin's IWRM

COMPONENT: I.1 Networks and Information Systems

STRATEGIC ACTION: I.1.1 Expansion and consolidation of monitoring networks

- Expansion and integration of centralized access to national data networks from climatological and hydro-meteorological stations that integrate the La Plata Basin's DSS, advancing joint work with the WIGOS-SAS projects. This includes the development of common standardization protocols for data compilation, processing, and storage.
- Integration of transboundary aquifers and water quality and quantity observation networks, defining and/or consolidating parameters.
- Expansion of surface and groundwater quantity and quality observation networks (physiochemical and biological aspects) in the La Plata Basin, promoting the incorporation of other topics of interest like erosion processes (bathymetry), invasive exotic species, and soil usage and current coverage, among others (including equipment).
- Expansion of the La Plata Basin network of meteorological radar and their interconnection, as well as the promotion and development of geostationary satellites specifically for hydro-meteorological applications.

STRATEGIC ACTION: I.1.2 Expansion and integration of information systems

- Updating (in accordance with agreed upon protocol for the five countries) and expanding available cartographic information in DSS-Plata, promoting exchange and coordination among the responsible bodies from each country.
- Expansion of the DSS-Plata's digital library of studies, macro- and micro-regional and territorial plans, hydraulic resource plans, and catalog of legislation and legal frameworks regarding the shared management of hydraulic resources, among other topics.

COMPONENT: I.2 Hydro-environmental monitoring and hydrological warning

STRATEGIC ACTION: I.2.1 Design and implementation of a hydro-environmental monitoring system in La Plata Basin

- Design and implementation of a hydro-environmental monitoring system of common interest at the La Plata Basin level. Implementation of hydro-environmental monitoring, with operating detail in the critical basins and sub-basins and at the regional level.
- Coordination and integration of the monitoring of identified variables—generated by the country systems—and complementary information, taking into account planning and alert objectives at the La Plata Basin level.

STRATEGIC ACTION: I.2.2 Consolidation of the La Plata Basin hydrological alert system

- Optimization, integration, and interconnection of existing alert systems (at the national and regional levels) in the area of DSS-Plata. Consideration of systems of support for integral risk management by sub-basins (operated at the country/state/province level) in the CIC jurisdiction.
- Expansion of the qualitative and quantitative aspects of DSS-Plata for IWRM, for use in navigation, hydroenergy, and agrometeorological prognostics. Implementation of hydrological models at the basin and/or sub-basin levels, integrated as permanently part of DSS-Plata.
- Replication and expansion of the Paraguay-Paraná and Cuareim/Quaraí Confluence Pilot Projects for risk management and implementation of early alert systems in transboundary areas.

way that balances economic and social interests and the social demands of a healthy and functioning environment in ecosystemic terms.

The concept of food security will be given particular emphasis within the context of climate variability and change, particularly in zones that are more vulnerable and of high social impact, seeking to promote the development of sustainable and resilient productive systems, incorporating soil, water, and ecosystem protection practices, improving efficiency and risk development and other uses of water.

Additionally, it will provide follow-up concerning the integration of La Plata Basin countries, through actions related to the basin's development, sustainable energy potential, and river transport, in the context of environmental challenges caused by climate variability and change.

The strategic area includes the following components and actions:

Component II.1: Integrated Water Resource Management and Adaptive Measures

This component comprises actions aimed at reducing ecosystem vulnerability through the management of hydraulic resources, as a central component of the overall management of the development of the basin.

The potential impacts of climate variability and change on the availability of water resources, as well as its effects on the well-being of the population and region's economies are identified within this component. Proposals will be developed to improve access to water resources for: productive development and the needs of the populations in areas of water stress; enhanced planning systems; integrated and sustainable use of surface and groundwater resources in critical vulnerable areas of water stress; and development and realization of contingency plans and programs to reduce the potential impact prior to disasters.



Biodiversity in the upper Paraná.

The proposed strategic actions are:

***Strategic action II.1.1
Integrated management of superficial and
groundwater resources in critical zones***

Water is recognized as the fundamental component of sustainable development for the Basin, acknowledging that water quantity and quality is, generally, what limits the possibility of future development and impacts the sustainability of current development. For this reason, actions will be developed that seek to improve the optimization of hydraulic resources within ecosystems and critical zones, with the goal of increasing and improving access to hydraulic resources for productive development and to meet population needs. It will promote, in particular, the sustainable use of aquifers to meet development needs, seeking to expand and standardize water provision and its efficient use, with the objective of reducing potential impact in areas under water stress.

In accordance with the TDA studies and quantitative estimates regarding water demands, the zones with existing or potential conflict in the Basin, which should afford priority, are: i) the Pilcomayo and Bermejo River zones, due to diffuse water contamination from agriculture, mining, and hydric erosion; ii) the Tietê River zone —Metropolitan Area of San Pablo— due to high water demands, contaminated water sources, low flow rates, and therefore, low assimilative capacity of urban contamination in the headwaters of the basin; and iii) rice production zones in Brazil, Uruguay, and Argentina, with high water demand for irrigation and potential conflicts with urban uses.

Similarly, this action will encourage aquifer management and the integrated and sustainable use of surface-groundwater re-

sources for the benefit of the local communities of the Basin. It will monitor with particular attention the Yrendá-Toba-Tarijeño Aquifer System (YTTAS) —which covers approximately 350,000 km, the most important fresh water reservoir of the South American Chaco, which has experienced a significant increase in water extraction through perforations during recent years. For this reason, it is necessary to guarantee its sustainable management, ensuring the continuity of its recharge and preservation of water quality, taking into consideration risks associated with climate variability and change. Likewise, it is considered a priority to advance with the consolidation and replication of the Cuareim/ Quaraí Pilot Program as a participative management experience, including the development and implementation of hydraulic methodologies. It will promote the structures created in the region like CEREGAS (Regional Center for Subterranean Water Management), category Z of UNESCO in Uruguay.

The proposed activities under this category include:

- Integrated management (hydraulic availability-use-demand, ecological flow) in select basins. This includes the expansion and replication of the Cuareim/Quaraí Pilot Program and the priority project Yrendá-Toba-Tarijeño (YTTAS), as well as the development of projects in the Acaray-Caiua aquifer and priority semi-arid areas, among others.
- Management of hydraulic resource demand: stimulus of rational and multiple use, reutilization of water, equipment for storage, water loss control, etc.
- Deepening of knowledge and systemization of information regarding groundwater in critical transboundary aquifer

fers, especially in areas under hydraulic stress seeking water security.

- Prioritization of aquifers based on their social and environmental impact potential and on the interest of involved countries.
- Implementation of the SAP of the Guaraní Aquifer System, and management support.
- Development of criteria and proposal of actions for the protection of urban aquifers.
- Joint management of surface and groundwater, soil, and transboundary areas of interest, especially in incremental basins in the influence area of multinational reservoirs.

***Strategic action II.1.2
Land use planning and restructuring in priority vulnerable priority areas***

This strategic action seeks to improve urban and territorial planning, promoting territorial restructuring as a primary instrument for determining land use and economic activities reliant on natural resources. It promotes improved resilience and reduced vulnerability to extreme events, particularly floods and droughts.

The actions will be carried out at the local level, complementing technical, institutional, and legal efforts at the provincial and municipal levels in vulnerable areas, with the goal of enabling the application of zoning and territorial restructuring, in accordance with each country's guidelines, as normative instruments for territorial occupation. It is hoped that these actions will contribute to reducing the impacts of climate vulnerability and change on major populated areas.

At the regional level, actions will be developed to promote agro-ecological zoning of priority agro-ecological areas (micro basins or sub-basins), strengthening the technical and local capacities of local governments in terms of planning and resource management, within the context of predicted impacts on the availability of hydraulic resources due to the effects of climate variability and change, identifying needs and adaptation measures.

The actions will be carried out first in priority and vulnerable zones of the Basin, with the goal that these will serve as a base from which to promote their expansion and application in other areas of the Basin.

The proposed activities under this action include:

- Zoning of transboundary flood zones, taking into consideration risk levels.
- Elaboration of territorial and climate vulnerability maps by basin, taking into consideration the multiple uses of water, as well as the development of local plans for the implementation of adaptation and mitigation methods.
- The elaboration of an ecological vulnerability map to land use and climate changes at the ecosystemic level.
- Zoning of protected areas based on vulnerability and risk of contamination of aquifer recharge areas.
- Agroecological zoning in priority productive areas, wetlands, forests, etc.
- Elaboration of urban and rural territorial restructuring plans, taking into consideration the effects of climate change

and floods, agroecological, and ecological conservation areas.

- Development and implementation of harmonized territorial planning policies and integrated hydraulic resource management.

Strategic action II.1.3

Water supply management program

Includes actions aimed at guaranteeing water supply for human and productive activities, so as to be able to cope with periods of low flows and droughts or any imbalance between supply and demand resulting in restrictions on water consumption and, consequently, on economic and regional development. Similarly, it includes activities to ensure that water quality standards clearly defined for specific uses are met, either in normal situations or especially facing the occurrence of accidental contaminant spills.

The proposed strategic activities under this action include:

- Identification of regions in vulnerable situations with respect to water supply and demand, in terms of both quantity and quality.
- Development and implementation of structural methods (reservoirs, canals, dams, etc.) to guarantee water supply to the most vulnerable sector of water consumers.
- Development and implementation of non-structural methods: consent of water use rights, revision of water use rights in critical situations of water quality and quantity, etc.
- Management of water resource demand: incentives for rational and multiple use, water reuse, water-saving equipment, water loss control, etc.
- Zoning of areas vulnerable to accidental contaminant spills.
- Consolidation and expansion of water quality monitoring networks (in coordi-



Jaguar in the Gran Chaco Americano.

nation with I.1). Accreditation of regional environmental quality analysis laboratories, to form surface and groundwater monitoring and aquatic biota monitoring networks, among others.

Strategic action II.1.4
Risk management and adaptive measures program

The extreme hydrological events linked to climate variability and change affect parts of the Basin, in particular, prolonged floods and reoccurring and intense, extended periods of drought, which cause devastating social, economic, and environmental consequences. During El Niño of 1982–83, for example, the estimated losses for La Plata Basin totaled more than a million dollars. In the case of droughts, the dry years led to a 5% drop in GDP.

During moderate events associated with seasonal cycles, the natural fluctuations in water availability and the fluvial morphological dynamics influence the development and use of hydraulic resources. On the one hand, overall water scarcity is observed during dry periods, with water use limited to human consumption and agricultural and farming purposes, resulting in consequences such as low levels of production and economic returns. On the other hand, periods of water excess lead to flooding in both urban and rural zones.

This strategic action aims to develop strategies for integral risk management, which takes into consideration its distinct dimensions. The proposals address disaster prevention through improved preparation of civil society and responsible institutions; the mitigation of effects caused by disasters, reducing vulnerability and threats to life and property damage; and the prevention of risk (long term). It identifies and

analyzes threats and vulnerabilities, developing activities during interconnected prevention phases. The proposed activities complement those of component I.2 Hydro-environmental monitoring and hydrological warning, as well as the activities of IV.3 Communication and public participation, particularly in reference to the development of actions aimed at raising risk awareness, involving authorities, achieving community participation, and reducing economic and social loss.

The activities of this strategic action include, among other things, the following:

- Flood defense projects and/or piping and/or retention of excess water in critical regions vulnerable to floods.
- Dam construction projects, drilling of wells, and the expansion of treatment plants for critical regions vulnerable to floods.
- Consolidation and replication of Confluence Pilot Program with respect to plans for addressing critical situations and risk management in the face of accidents and disasters.
- Development of regional hydro-environmental accident and disaster prevention and reduction policies.
- Post-emergency recovery plans.
- Contingency plans for vulnerable urban areas, promoting the twinning of cities.
- Regional contingency plans prior to extreme hydrological events.
- Contingency and risk management plans for hydro-environmental accidents and disasters (dam security).

Component II.2: Sustainable Productive Development

Aims to improve income and the quality of life of small producers and communities, particularly those located in vulnerable areas, revaluing the environmental function of ecosystems and the multiple potential uses of water resources available in the Basin. To this end, actions will be carried out aimed at implementing sustainable production practices and soil, water, and ecosystem protection to promote the advancement of fishing and aquaculture, ecotourism, and the use of clean technologies. In developing these actions, the main focus will be on food security, taking into account the effects of climate variability and change.

This component includes the following strategic actions:

Strategic action II.2.1

Promote farming systems resilient to climate variability and change

The La Plata Basin, one of the most important areas of food production in the world, is also identified as one of the most vulnerable to the impacts of climate change. According to the studies developed by the TDA, the climate scenarios present an increase in precipitation towards the end of the century, in comparison to the climate conditions of 1961–1990. The studies also predict an increase in temperature throughout the XXI century.

The consequences of these scenarios increase the likelihood of damages, which could have an exacerbated effect on agriculture, considering that the sector is the top consumer of water in the Basin, accounting for 70% of consumptive use. In the context of precipitation and flow reduc-

tion in the high basins, grain production would be the most impacted, principally in the central-west region of Brazil, which is currently the region with the highest degree of agricultural productivity. On the other hand, water availability for agricultural production in the low basins in Argentina and Uruguay would improve.

With regard to both water scarcity and greater availability of water resources, it is necessary to address the issue of resilience with respect to productive systems, seeking not only to develop robust food systems in the face of climatic disturbances, but also to ensure adaptation, response, and recovery capacity, helping to reduce potential impacts.

First, the studies developed during the TDA process will be further developed to emphasize analysis of the potential impacts of climate variability and change on the principal productive zones of the basin.

Some of the activities proposed under this strategic action include:

- Increase in the level of knowledge on the impacts on agricultural productivity in the principal agricultural regions, in the context of climate variability and change, including the development and adaptation of agricultural production models in La Plata Basin.
- Support for availability and access to meteorological data and information (weather predictions and seasonal climate tendencies) to improve the planning capacity of governmental organizations, private institutions, and/or producers.
- Foster local capacity that promotes efforts aimed at improving plans and ac-

tions related to food security at the local/ community level.

- Improvement of production in vulnerable zones through agroecological zoning of the principal productive areas vulnerable to climate variability and change at the municipal, provincial, and national levels, in coordination with strategic area II.1.2.
- Development and implementation of adaptation measures in pilot areas, including sustainable agricultural practices, use of resistant varieties, and/or crops adapted to new climatic conditions, and the adoption of sustainable irrigation techniques, among others.
- Development and implementation of agricultural safeguards to address the consequences of extreme events (droughts and floods) in La Plata Basin.
- Identify, develop, and promote horizontal integration/cooperation strategy associated with agricultural production.

Strategic action II.2.2 **Fishing and aquaculture program**

The rich aquatic life of the region represents a key resource for La Plata Basin, with river-based populations closely linked to the exploitation of ichthyic resources. According to the TDS studies, 40% (367) of the region's fish species are of socio-economic importance, as resources for commercial, artisanal, subsistence, and recreational fishing. The use and value that is given to ichthyofauna has greater transcendence in the sub-basins of the Paraguay (upper and lower) and the Paraná (lower).

Some of the species (tarpon, surubi, mahi-mahi) are being subjected to intense ex-

ploitation in some areas, after having been retracted as a fishable stock due to high demand for fish. Additionally, multiple populations of fish are being impacted because of anthropic action, principally due to the effects of contamination from various types of effluents, construction of infrastructure projects, and the drying up of wetlands for conversion into agricultural and farming areas. At the same time, there are close to 1,500 farms or confinements of exotic species in La Plata Basin, especially in the upper and lower Paraná basins, which constitute a strong threat due to the likelihood of escape of species that eventually could become invasive.

This strategic action seeks to promote the rational and sustainable use of fishery resources. To fulfill this objective, it will work at different levels to develop and promote integrated policy, norms, and compatible criteria at the basin level, operating in particularly critical and vulnerable zones, with actions oriented towards strengthening local capacities to develop control and management tools and mechanisms, and to implement actions to prevent and reverse the reduction of fishable stocks. Also, in coordination with strategic the area Capacity building and social participation, it will develop and implement awareness and capacity-building programs in sustainable fishery techniques and aquaculture development.

In general terms, the activities under this strategic action include the following:

- Joint management of preventative measures for the control of fish fauna resources, sport fishing, and aquaculture.
- Restructuring plans, regulation of fishing activity, and management of fish fauna and aquaculture resources.

- Harmonization of fishing legislation and norms.
- Consolidation of sports fishing standards at the sub-basin level.
- Strengthening the application of the FAO Code of Conduct for responsible fishing.
- Establishment of environmental and ecological monitoring networks.
- Development of preventative programs for the control of fishing and aquaculture.
- Monitoring and control of exotic species.
- Promotion of nature tourism and the development of restructuring plans and regulations pertaining to fishing activity.
- Vulnerability studies of priority river habitats.
- Capacity-building and awareness program in the principal community fisheries.

Strategic action II.2.3 Ecotourism program

The Basin is a region with noteworthy ecosystems, from the Iguazú Falls to the wetlands corridor that connects the Pantanal with the Paraná Delta in its La Plata River estuary, and constitutes an important fresh water reserve with a wealth of biological and cultural diversity, highly appropriate for the implementation of sustainable development strategies. Among these, those which are oriented toward the promotion of ecotourism programs and projects with minimum impact to ecosystems that provide a source of revenue for quality of life improvements for local communities, and at the same time promote participatory mechanisms to protect the environment stand out.

In 2012, during the Ramsar Convention on Wetlands, tourism was officially recognized as one of the many ecosystem services that wetlands promote, identifying the distinct aspects that must be taken into account (at the national and local levels) to ensure the sustainability of wetland tourism, in accordance with the “rational use” principle established by the convention, highlighting the value of wetlands for tourism, as well as the economic benefits from tourism that can contribute to wetlands management.

In this regard, this strategic action seeks to promote ecotourism as a means by which to improve income generation for local communities, and as strategy for protection of ecosystems and the management of protected areas. In accordance with what has been identified by the TDA, particular attention will be given to the sub-basin of the lower Uruguay, which is composed of a series of islands and coastal wetlands, and which merits special attention in terms of management. Due to its natural and cultural wealth, this zone represents important potential for ecotourism and nautical tourism, and therefore is a high conservation priority.

The activities proposed under this strategic action include:

- The development and promotion of ecotourism initiatives in protected areas and buffer zones.
- Strengthening capacity at the local and community levels to improve the offer of tourism services. Support in the planning, introduction, and optimization of ecotourism as a source of revenue and of ecosystem protection. Implementation of shared ecotourism practices in trans-boundary areas.

- Promotion and development of rural and community tourism in border areas.
- Nautical development and ecotourism project in the lower basin of the Uruguay River.
- Development and integration of river routes and ecotourism in tourism packages.

Strategic action II.2.4 **Clean technology program**

One of the critical thematic areas defined for the La Plata Basin in the loss of water quality. The problem originates from organic contaminants and chemicals coming from point-source contamination (industrial activities, mining, waste water, and sewage from urban centers), as well as from sources of diffuse contamination, primarily agricultural activity that uses intensive agrochemicals. In accordance with the studies and analysis developed during the TDA, it is generally observed that for the Basin as a whole, organic contamination of diffuse origin predominates over point-source contamination. Nevertheless, both are equally present in the Paraná sub-basin, affording it particular importance in the case of the La Plata River sub-basin. This would explain the presence of large metropolises in these sub-basins like San Pablo and Buenos Aires, respectively.

In the Paraná River, it is evident that the industrial effluents from industries tied to agricultural activities —like cattle farming, sugarcane cultivation, and pig and chicken farming— represent important sources of organic contamination. Contamination problems are present in the lower basin of the Paraná River, mainly in the large urban conglomerates like the cities of Rosario and Santa Fe that are located along the banks of the Paraná River, and in zones

with industrial development like the city of Esperanza, characterized by the presence of leather factories that spill their effluents into the northern zone of the basin of the Salado River, a tributary of the Paraná River.

In the lower section of the Paraguay River, the majority of contaminants mostly come from the discharge from domestic and industrial effluents in areas near large urban centers, like Concepción, Asunción, and Pilar. The studies realized reveal that a high concentration of carbonic acid exists —indicating probable contamination coming from industries such as timber— throughout the Paraguay River, in Humaitá, and in one of its tributaries, the Apa River. Carbonic acid is highly toxic to aquatic species and cannot be broken down biologically.

In the upper basin of the Uruguay River, the majority of the industrial contamination is found in the tributaries, the Peixe and Canoas Rivers, which receive high levels of contamination from point and diffuse sources due to the industrial activity in the state of Santa Catarina. The effluents, which originate from the paper, leather, and food industries of the cities of Caçador and Videira (in the basin of the Peixe River) and Lages (in the basin of the Canoas River), represent a major source of contamination due to heavy metals and other substances, in addition to organic material. These loads have increased due to growth in production, outsourcing of industrial processes, and difficulty in the treatment of small loads, which have led to a rise in diffuse loads in the Basin.

In the La Plata River, the majority of contamination is of urban-industrial origin, coming from the city of Buenos Aires and its surrounding areas, as well as La Plata and Gran La Plata. The Matanza-Riachuelo and Reconquista Rivers stand out due to

their high levels of contamination, as well as numerous streams and aqueducts.

This Strategic action seeks to complement the activities under component III.3 Environmental sanitation. Whereas component III comprises environmental protection and rehabilitation actions, with activities aimed at controlling and reducing diffuse pollution (agricultural activity) and point source pollution due to sewage and urban effluents, this strategic action belongs to the group of strategic actions aimed at improving income generation and quality of life for small-scale producers and communities implementing sustainable production practices. In this regard, the activities seek to develop actions that stimulate the employment of clean technologies and minimization of waste.

The activities proposed under this strategic action category include:

- Promotion of public-private associations that incentivize the use of clean production systems throughout the production chain.
- Strengthening business capacity and community entrepreneurship for the production of goods and services in a manner that is environmentally sustainable and responsible.
- Strengthening the capacity of provincial, departmental, and community centers to assist in the development of clean production policies, including the preparation of environmental best practices manuals for different industrial sectors.
- Support the development of voluntary mechanisms with the goal of increasing the adoption of clean technologies and strengthening environmental performance.
- Exchange of experiences regarding the disposal and recycling of solid waste in urban areas.
- Environmental Quality Management for the private sector, in particular for the mining, manufacturing, agricultural, and energy sectors.



International meeting for TDA consolidation and recommendations for the SAP in Foz de Iguazu, Brazil, in 2015.

Component II.3: Water Resource Use in the Context of Regional Integration

Since the implementation of the La Plata Basin Treaty and the creation of the CIC, the body that promotes its objectives, areas of common interest among the five countries have been prioritized, facilitating the realization of studies, programs, and infrastructure projects related to hydrology, natural resources, transportation and navigation, land, and energy. The focus of the treaty was innovative and important because of its integrated development proposal, enabling business development to promote important investments in energy potential and river transportation, among other areas.

The emphasis placed on hydroenergy and navigation is evident in the strategic character of these activities. Navigation constitutes one of the most fundamental socioeconomic sectors in the development and integration of the LPB, to allow the connection between the centers of production and storage and the ports from which principal products are exported to the world. Hydroenergy is also a key element identified for socioeconomic integration, as a large portion of the hydroelectricity generated in the countries originates from the La Plata Basin, with a high percentage of the power generated locally in transboundary areas. Opportunities for synergy to promote the production and transmission of energy exist between the countries.

During the last 25 years, the intensification of the rhythm and duration of the alternate periods of drought and flooding—with significant impacts on society, national economies, and the environment—has been apparent. Recognizing the importance of the energy and naviga-

tion sectors for the socioeconomic development of the countries of the Basin, this component aims to identify in a precise manner the potential impacts of climate variability and change, proposing adaptation measures to reduce or mitigate its principal effects.

The strategic actions and activities proposed under this component are:

Strategic action II.3.1

Enhance river navigation as a mode of transportation and regional integration

The statistical information available and the projections carried out in diverse studies on navigation in the La Plata Basin reveal a sustained rise in the use of river transportation. With that said, it is of interest to identify which aspects can be improved to contribute to a more vigorous development of this mode of transportation, whose comparative advantages in terms of environmental sustainability are widely recognized, from the point of view of reduced energy consumption by unit of transportation (and consequently, less emissions), as well as associated accidents.

The climate scenarios identified as most probable for the rest of the XXI century for the southeast region of South America (where the La Plata Basin is located) project, in global terms, an increase in average temperatures and in precipitation (although not uniformly distributed); an increase in river discharge, most likely in greater proportion than rainfall, taking into consideration the changes in land use that can increase run-off; and increased frequency of extreme climate events. With respect to the development of navigation, it is possible to identify two relevant consequences of the aforementioned hypothesis. On the one hand, the probable increase in riv-

er discharge allows one to assume a correlative increase in water depths throughout the navigable routes of the region, with the consequent potential improvement of navigation conditions. And, on the other hand, an increase in the transport of suspended solids is also probable, with the consequence of increased risk of sedimentation, and, therefore, a reduction in the depths in various parts of the river network.

These aspects would play, as is evident, opposing roles with regard to optimization of river navigation. Precise quantifications of the impacts of the climate scenarios referred to are currently not available.

The actions under this strategic action are aimed at promoting the development of navigation in the La Plata Basin by overcoming the primary obstacles currently impeding transboundary river navigation, taking into consideration the potential impacts of climate variability and change.

The activities proposed under this strategic action include the following:

- Development of studies and modeling to project the impacts of climate variability and change on the main water-

ways, identifying measures for adequate maintenance and potential improvement of navigation conditions. Reduction of vulnerability associated with river transport and port undertakings.

- Evaluation of obstacles to navigation in terms of potential for ecotourism, in addition to the impediments of the intermodal infrastructure available at the local and regional levels.
- Integration of statistical information banks to ensure centralized, objective, and regular provision of data on the Basin, in a manner that allows for the realization of reliable analysis of the development of river transportation in the region, the formulation of projections, and planning of eventual improvements.
- Incentivize the construction of a system of canals in the hydroelectrical reserve of Itaipú that maintains the 120-meter difference in elevation that the dams create, in order to complete the integration of close to 7,000 kilometers of rivers and the waterways in the region.
- Consolidation of the Paraguay-Paraná Waterway Program as an area of naviga-



Pilcomayo River.

tion integration and potential. Promote safe and economical river transportation.

- Incentivize the countries of La Plata Basin to continue working to strengthen their relations and to improve their waterways to facilitate foreign commerce.

Strategic action II.3.2

Defining hydroelectric systems in the context of climate variability and change

Climate change can trigger disturbances in the economy and in the management of water resources, which can directly impact hydroelectric power plants and negatively affect energy generation. In the La Plata Basin, the existing dams have been utilized to regulate the disbursement of water, with the goal of managing extreme flooding. Transboundary integration is fundamental in this context. Argentina, Bolivia, Brazil, Paraguay, and Uruguay need to intensify the integration of their meteorological systems, their hydraulic resources, and their hydraulic energy availability in order to maximize the benefits of climate variation, which has led to a significant increase in water availability. These actions, however, must not overlook the importance of protecting soil and water use, especially water below the dams.

Given the uncertainty of current climate models in terms of predicting future precipitation levels in the watersheds, it would be advisable to reduce the vulnerabilities that exist today in order to maintain and expand hydroelectric energy generation in La Plata Basin. With this purpose, the activities proposed under this category include:

- Development of a hydroelectric energy generation diagnostic in the existing power plants, focused on the multiple

uses of water during periods of either extreme drought or flooding, to better meet the growing population and economic needs of the Basin. It is also necessary to evaluate the need for actions to remove sediment from the bottom of the reservoirs to ensure greater water storage capacity, achieve greater energy generation capacity, and extend the useful life of this type of infrastructure.

- Stimulate greater regional integration among the different watersheds, as well as among the existing electrical systems within each one, in a way that reduces the vulnerability of the energy and water supply.
- Implement an interconnected system to guarantee compensation for seasonal imbalances between basins and integrate the electric energy markets of the countries that comprise the La Plata Basin.
- Develop and implement nonstructural methods to promote the adaptive management of water supply systems, such as the restructuring of water provision systems and the integration of alternative water supply systems, revising the operating norms of the hydroelectric plants during contingency periods.
- Unite information about the operating systems of the hydroelectric plants that supply potable water and water for irrigation.
- Institutional strengthening to expand the coordination of spatial-temporal offerings with water and energy demand, in other words, between river basins and rural and urban energy supply systems, taking into account seasonal variation and climate variation and change.

Table 4

Strategic action II - Components - Strategic actions – Activities

STRATEGIC AREA II: PLANNING, MANAGEMENT, AND SUSTAINABLE USE OF WATER RESOURCES

COMPONENT: II.1 Integrated water resource management and adaptive measures

STRATEGIC ACTION: II.1.1 Integrated management of surface and groundwater in critical areas

- Integrated management (hydraulic availability–use–demand, ecological flow) in select basins. This includes the expansion and replication of the Cureim/Quaraí Pilot Program and the priority project Yrendá–Toba–Tarijeño (YTTAS), as well as the development of projects in the Acaray–Caiua aquifer and priority semi–arid areas, among others.
- Management of hydraulic resource demand: stimulus of rational and multiple use, reutilization of water, equipment for storage, water loss control, etc.
- Deepening of knowledge and systemization of information regarding groundwater in critical trans–boundary aquifers, especially in areas under hydraulic stress seeking water security.
- Prioritization of aquifers based on their social and environmental impact potential and on the interest of involved countries.
- Implementation of the SAP of the Guarani Aquifer System, and management support.
- Development of criteria and proposal of actions for the protection of urban aquifers.
- Joint management of surface and groundwater, soil, and transboundary areas of interest, especially in incremental basins in the influence area of multinational reservoirs

STRATEGIC ACTION: II.1.2 Land use planning and restructuring in priority vulnerable areas

- Zoning of transboundary flood zones, taking into consideration risk levels.
- Elaboration of territorial and climate vulnerability maps by basin, taking into consideration the multiple uses of water, as well as the development of local plans for the implementation of adaptation and mitigation methods.
- The elaboration of an ecological vulnerability map to land use and climate changes at the ecosystemic level.
- Zoning of protected areas based on vulnerability and risk of contamination of aquifer recharge areas.
- Agroecological zoning in priority productive areas, wetlands, forests, etc.
- Elaboration of urban and rural territorial restructuring plans, taking into consideration the effects of climate change and floods, agroecological, and ecological conservation areas.
- Development and implementation of harmonized territorial planning policies and integrated hydraulic resource management

STRATEGIC ACTION II.1.3 Water Supply Management program

- Identification of regions in vulnerable situations with respect to water supply and demand, in terms of both quantity and quality.
- Development and implementation of structural methods (reservoirs, canals, dams, etc.) to guarantee water supply to the most vulnerable sector of water consumers.

Strategic action II - Components - Strategic actions – Activities (cont.)

STRATEGIC AREA II: PLANNING, MANAGEMENT, AND SUSTAINABLE USE OF WATER RESOURCES

- Development and implementation of non-structural methods: consent of water use rights, revision of water use rights in critical situations of water quality and quantity, etc.
- Management of water resource demand: incentives for rational and multiple use, water reuse, water-saving equipment, water loss control, etc.
- Zoning of areas vulnerable to accidental contaminant spills.
- Consolidation and expansion of water quality monitoring networks (in coordination with I.1). Accreditation of regional environmental quality analysis laboratories, to form surface and groundwater monitoring and aquatic biota monitoring networks, among others.

Strategic action: II.1.4 Programa de gestión de riesgo y medidas de adaptación

- Flood defense projects and/or piping and/or retention of excess water in critical regions vulnerable to floods.
- Dam construction projects, drilling of wells, and the expansion of treatment plants for critical regions vulnerable to floods.
- Consolidation and replication of Confluence Pilot Program with respect to plans for addressing critical situations and risk management in the face of accidents and disasters.
- Development of regional hydro-environmental accident and disaster prevention and reduction policies.
- Post-emergency recovery plans.
- Contingency plans for vulnerable urban areas, promoting the twinning of cities.
- Regional contingency plans prior to extreme hydrological events.
- Contingency and risk management plans for hydro-environmental accidents and disasters (dam security).

COMPONENT: II.2 Sustainable productive development

STRATEGIC ACTION: II.2.1 Promote farming systems resilient to climate variability and change

- Increase in the level of knowledge on the impacts on agricultural productivity in the principal agricultural regions, in the context of climate variability and change, including the development and adaptation of agricultural production models in La Plata Basin.
- Support for availability and access to meteorological data and information (weather predictions and seasonal climate tendencies) to improve the planning capacity of governmental organizations, private institutions, and/or producers.
- Foster local capacity that promotes efforts aimed at improving plans and actions related to food security at the local/ community level.
- Improvement of production in vulnerable zones through agroecological zoning of the principal productive areas vulnerable to climate variability and change at the municipal, provincial, and national levels, in coordination with Strategic action II.1.2.
- Development and implementation of adaptation measures in pilot areas, including sustainable agricultural practices, use of resistant varieties, and/or crops adapted to new climatic conditions, and the adoption of sustainable irrigation techniques, among others.
- Development and implementation of agricultural safeguards to address the consequences of extreme events (droughts and floods) in La Plata Basin.
- Identify, develop, and promote horizontal integration/cooperation strategy associated with agricultural production.

STRATEGIC AREA II: PLANNING, MANAGEMENT, AND SUSTAINABLE USE OF WATER RESOURCES

STRATEGIC ACTION: II.2.2 Sustainable Fisheries and aquaculture program

- Joint management of preventative measures for the control of fish fauna resources, sport fishing, and aquaculture.
- Restructuring plans, regulation of fishing activity, and management of fish fauna and aquaculture resources.
- Harmonization of fishing legislation and norms.
- Consolidation of sports fishing standards at the sub-basin level.
- Strengthening the application of the FAO Code of Conduct for responsible fishing.
- Establishment of environmental and ecological monitoring networks.
- Development of preventative programs for the control of fishing and aquaculture.
- Monitoring and control of exotic species.
- Promotion of nature tourism and the development of restructuring plans and regulations pertaining to fishing activity.
- Vulnerability studies of priority river habitats.
- Capacity-building and awareness program in the principal community fisheries.

STRATEGIC ACTION: II.2.3 Ecotourism program

- The development and promotion of ecotourism initiatives in protected areas and buffer zones.
- Strengthening capacity at the local and community levels to improve the offer of tourism services. Support in the planning, introduction, and optimization of ecotourism as a source of revenue and of ecosystem protection. Implementation of shared ecotourism practices in transboundary areas.
- Promotion and development of rural and community tourism in border areas.
- Nautical development and ecotourism project in the lower basin of the Uruguay River.
- Development and integration of river routes and ecotourism in tourism packages.

STRATEGIC ACTION: II.2.4 Clean technology program

- Promotion of public-private associations that incentivize the use of clean production systems throughout the production chain.
- Strengthening business capacity and community entrepreneurship for the production of goods and services in a manner that is environmentally sustainable and responsible.
- Strengthening the capacity of provincial, departmental, and community centers to assist in the development of clean production policies, including the preparation of environmental best practices manuals for different industrial sectors.
- Support the development of voluntary mechanisms with the goal of increasing the adoption of clean technologies and strengthening environmental performance.
- Exchange of experiences regarding the disposal and recycling of solid waste in urban areas.
- Environmental Quality Management for the private sector, in particular for the mining, manufacturing, agricultural, and energy sectors.

Strategic action II - Components - Strategic actions – Activities (cont.)

STRATEGIC AREA II: PLANNING, MANAGEMENT, AND SUSTAINABLE USE OF WATER RESOURCES

COMPONENT: II.3 Water resource use in the context of regional integration

STRATEGIC ACTION:

II.3.1 Enhance river navigation as a mode of transportation and regional integration

- Development of studies and modeling to project the impacts of climate variability and change on the main waterways, identifying measures for adequate maintenance and potential improvement of navigation conditions. Reduction of vulnerability associated with river transport and port undertakings.
- Evaluation of obstacles to navigation in terms of potential for ecotourism, in addition to the impediments of the intermodal infrastructure available at the local and regional levels.
- Integration of statistical information banks to ensure centralized, objective, and regular provision of data on the Basin, in a manner that allows for the realization of reliable analysis of the development of river transportation in the region, the formulation of projections, and planning of eventual improvements.
- Incentivize the construction of a system of canals in the hydroelectrical reserve of Itaipú that maintains the 120-meter difference in elevation that the dams create, in order to complete the integration of close to 7,000 kilometers of rivers and the waterways in the region.
- Consolidation of the Paraguay-Paraná Waterway Program as an area of navigation integration and potential. Promote safe and economical river transportation
- Incentivize the countries of La Plata Basin to continue working to strengthen their relations and to improve their waterways to facilitate foreign commerce.

STRATEGIC ACTION:

II.3.2 Defining hydroelectric systems in the context of climate variability and change

- Development of a hydroelectric energy generation diagnostic in the existing power plants, focused on the multiple uses of water during periods of either extreme drought or flooding, to better meet the growing population and economic needs of the Basin. It is also necessary to evaluate the need for actions to remove sediment from the bottom of the reservoirs to ensure greater water storage capacity, achieve greater energy generation capacity, and extend the useful life of this type of infrastructure.
- Stimulate greater regional integration among the different watersheds, as well as among the existing electrical systems within each one, in a way that reduces the vulnerability of the energy and water supply.
- Implement an interconnected system to guarantee compensation for seasonal imbalances between basins and integrate the electric energy markets of the countries that comprise the La Plata Basin.
- Develop and implement nonstructural methods to promote the adaptive management of water supply systems, such as the restructuring of water provision systems and the integration of alternative water supply systems, revising the operating norms of the hydroelectric plants during contingency periods.
- Unite information about the operating systems of the hydroelectric plants that supply potable water and water for irrigation,
- Institutional strengthening to expand the coordination of spatial-temporal offerings with water and energy demand, in other words, between river basins and rural and urban energy supply systems, taking into account seasonal variation and climate variation and change.

STRATEGIC AREA III. ENVIRONMENTAL PROTECTION / REHABILITATION

This strategic area seeks to strengthen ecosystem conservation mechanisms and the prevention and control of environmental degradation processes affecting the La Plata Basin within the framework of climate variability and change. These actions are aimed at land recovery and conservation, erosion reduction, and eradication or reduction of pollution sources in order to mitigate negative effects on human health and promote the implementation of measures that contribute to urban sanitation.

The strategic area is organized into three components.

The first, III.1 *Ecosystem management*, includes strategic actions for the conservation and management of protected areas, including wetlands and Ramsar sites. It also considers management of living aquatic resources through the identification and protection of critical habitats for reproduction, species feeding and development, updating species inventories, and monitoring and control of both exotic aquatic species and invasive non-native species.

Component III.2 Sustainable land management consists of two strategic actions. The first is erosion and sedimentation control, laying the foundation for a land conservation program in the Basin and a commitment by all countries to reduce erosive processes and their environmental, social, and economic impacts. The second is the management and conservation of land and water through the implementation of good management practices, giving preference to mitigating diffuse erosion due to inadequate management of agricultural production. Finally, Component III.3 Environ-

mental Sanitation is focused on addressing pollution problems associated with agricultural activities, industry, mining, and deficiencies in basic sanitation (domestic sewage and industrial wastewater collection and treatment, urban sewage and solid waste), seeking to establish agreed-upon targets between countries for pollution reduction and recuperation in areas impacted by these problems.

The strategic actions identified for this component are to reduce pollutant sources (organic, chemical, and solid waste caused by industrial activity, mining, and agriculture) and improvements in urban sanitation and health (basic sanitation and establishing recovery targets agreed upon by the countries for pollution control and the mitigation of its effects to improve the health of the population).

Component III.1: Ecosystem management

This component comprises actions geared toward contributing to the sustainable management of biodiversity to guarantee its conservation.

It has a database that includes inventories of: i) fish species that inhabit the various sub-basins of the La Plata Basin, noting their conservation status, socio-economic importance, and origin (native/exotic); ii) exotic aquatic species and control measures; iii) the distribution of environments, protected areas, the characteristics and location of ecological corridors and/or their initiatives, national and regional biodiversity strategy analysis (and proposed guidelines for harmonization and the creation of a strategy for the whole Basin); and iv) wetland regions associated with the Ramsar initiative in the La Plata Basin.

Specific information has been replaced in the areas corresponding to pilot projects on biodiversity conservation in the regulated section of the Parana River between the Itaipu and Yacyreta reservoirs, where the fish fauna were inventoried, and an analysis of the fishing situation was performed and riverine areas (sections and areas of the Parana River) of importance for fish populations identified. A similar analysis was also conducted in the basin of the Cuareim/Quaraí River, a fish inventory was prepared and management measures proposed for this transboundary basin. The replica of the Cultivating Good Water (CGW) program in the Binational Itaipu in the micro-basins near the Yacyretá and Salto Grande dams also stands out as a case of good practices for successful participatory watershed management.

The following are the proposed strategic actions:

***Strategic action III.1.1
Conservation and expansion of protected areas and sustainable management of riparian and wetland ecosystems***

This strategic action intends to promote the management of the most significant threats to protected areas, including transboundary wetlands and Ramsar sites. To this end, it includes activities that seek to establish agreements and guidelines for joint action in conserving transboundary protected areas and wetlands; to promote conservation and restoration of riparian ecosystems through the creation and consolidation of ecological, river, and coastal corridors; the consolidation of transboundary protected areas, giving priority to the conservation and sustainable use of biodiversity and the protection of endangered species, habitats, and vulnerable ecosystems; thus connecting core areas (through

corridors) in order to promote recognition of their ecological importance and social, economic, cultural, scientific, and recreational value.

This strategic action will consider the most significant threats to biodiversity conservation systems detected in the TDA. Through this action, sustainable practices for managing aquatic ecosystems and recovery of threatened species populations and land and water conservation were replicated, thus pointing to the sustainable management of aquatic resources. In terms of topics related to wetlands and their associated ecosystems, coordination with the Ramsar Convention and other established organizations in the region to join efforts in environmental protection and rehabilitation and aligning priorities is expected. All measures to increase resilience are also important to address climate variability and change.

This strategic action proposes that the cross-border areas that need to be protected and evaluated and the most significant threats to which they are exposed be identified. These areas are located in the Pampa biome, which is critical; in the national parks in the region of Foz do Iguazu/Puerto Iguazu, between Brazil and Argentina; in the Itaipu-Yacyreta River section of the Parana River; in the river corridor stretch of the Pantanal in the upper basin of the Paraguay River; in the river section between the Foz do Chapeco and Salto Grande dams on the Uruguay River; and in the recharge areas of the main transboundary aquifers (Guarani, Yrenda-Toba-Tarijeño, Pantanal, etc.).

The activities planned under this strategic action include:

- Managing the most significant threats to protected areas, riparian and wetland

ecosystems, with an emphasis on Ramsar sites, considering shared prevention and mitigation guidelines, and emphasizing mining and hydrocarbon exploration.

- Shared guidelines for the prevention, mitigation, and connecting of transboundary protected areas. Inventory the Pampa biome. Promote integrated environmental management in the parks of the Foz do Iguacu region between Brazil and Argentina, the river section Itaipu-Yacyreta on the Parana River, the stretch of river between Foz do Chapecó and Salto Grande on the Uruguay River, and in the recharge areas of major transborder aquifers (Guarani, Yrenda-Toba-Tarijeño, Pantanal, etc.).
- Recovery and adaptation of the teachings of the Cultivating Good Water program and other successful initiatives surrounding conservation/rehabilitation of ecosystems, environmental management, and recovery of threatened species, with an emphasis on the active participation of local communities.
- Conservation and restoration of riparian and wetland ecosystems, with the creation and/or consolidation of forest, ecological, river, and coastal corridors, and transboundary protected areas. Identification of endemic and endangered species. Priority will be given to conservation and sustainable biodiversity use and the protection of threatened species, habitats, vulnerable ecosystems such as riparian forests, and ecological wealth, taking into consideration the cultural traditions of indigenous peoples and local communities.

***Strategic action III.1.2
Management of aquatic and other associated ecosystems***

Involves updating species inventories; the management and conservation areas important for the reproduction, raising, and feeding of (mainly) fish; and developing measures to control invasive, exotic, and non-native aquatic species.

This strategic action refers to management activities for aquatic resources and aquaculture. Its implementation will begin with the consolidation of existing diagnostics on critical transboundary areas for the control and management of invasive, exotic, and non-native aquatic species, and will be conducted in the face of demands for the protection and rehabilitation of associated ecosystems in areas around dams or hydraulic works, seeking to propose climate change adaptation measures focused on the preservation of endangered or threatened species. This consolidation will use pre-made diagnostics, supplemented in cases where new information is required. Projects with adaptive measures to increase resilience to climate variability and change will be developed. Some demonstrative pilot projects developed in the Framework Program that are relevant to this component are: the Demonstration Pilot Project for Biodiversity Conservation in a regulated area of the Parana River, the Demonstration Pilot Project for Pollution and Erosion Control in the Pilcomayo River, and the Cultivating Good Water project.

Now that the critical areas are established, projects for their implementation will be developed, with their respective demands for environmental protection, rehabilitation and prioritization. Measures to increase resilience are important to confront climate variability and change.

The inventory of species, as well as breeding areas and fish farms, will be updated and characterized, with an emphasis on the

presence of invasive, exotic, and non-native species in basins and sub-basins. The list of endangered species (or those under some level of threat) should also be updated. Subsequently, the joint management of aquatic resources and aquaculture in the La Plata Basin will be carried out, generating a cross-border strategy for the control and management of invasive, exotic, and non-native aquatic species. There also will be proposed mitigation solutions for the impact in the Upper Parana dams in the La Plata-Parana-Pantanal River axis, in coordination with II.2.2 Fishery and aquaculture program. Finally, the management of hydraulic works for the protection of fishable stock in coordination with strategic area II.2.2 Fishery and aquaculture program will be promoted.

The proposed activities around this topic are:

- Management of aquatic resources. To update and characterize the inventories of species, breeding grounds and nurseries, with an emphasis on the presence of invasive, exotic, and non-native species in basins and sub-basins. Consider in particular endangered species.

- Develop a cross-border strategy for the control and management of invasive, exotic, and non-native aquatic species, especially in the Upper Parana dams and in the La Plata-Parana-Paraguay-Pantanal river axis, in conjunction with strategic action II.2.2.
- Proposal for operating hydraulic works for the protection of fishable stock, in conjunction with strategic action II.2.2.
- Expansion and replication of the pilot project for the Conservation of Biodiversity in regulated areas.

Component III.2: Sustainable Land Management

Sustainable Land Management (SLM) was defined in the UN Earth Summit in 1992 as “the use of land resources, including soils, water, animals and plants for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.” In this context, this component comprises actions for erosion and sedimentation control in defined crit-



Bird migration zone on the Paraguay River.

ical areas, and the implementation of best practices in soil and water management and conservation for diffuse erosion control.

The La Plata Basin is one of the regions with the highest levels of sediment production in the world, carrying a volume of approximately 100 million tons per year in the Parana River, measured in the city of Corrientes (Argentina). Nearly 70% of suspended sediments in this section are from the Bermejo River, a transboundary basin between Bolivia and Argentina. Also, the deficiency or absence of the implementation of best practices in conservation and land management across the Basin comes coupled with one of the principal environmental problems with transboundary repercussions in the Basin: watercourse silting.

Excess sediment and nutrients in water—among which phosphorus stands out—also generate eutrophication and water quality deterioration, which results in algae blooms (commonly cyanobacteria and often toxic), deficits in dissolved oxygen, and kills fish and other aquatic organisms. These problems originate with accelerated soil erosion, transport, and sedimentation that has repercussions in soil loss and silting of the waterways.

The critical issues associated with land degradation and desertification are: soil loss, barriers to navigation, water quality degradation, need for water storage maintenance, and biodiversity variation, among others.

There are several programs and projects formed by two or more Basin countries that take action to conserve soils. The projects include: the Gran Chaco Americano sub-re-

gional action program; the strategic management program for the integrated management of the Pantanal and the Upper Paraguay basin; the master development and integrated management of water resources plan of the Pilcomayo River basin, and the integrated management program of the Bermejo River basin. Of interest to the La Plata Basin SAP, three main contributions stand out in this component:

- The study of Bermejo River⁴ basin and the Pilcomayo River, as good background for a comprehensive study on the erosion and sedimentation problem, with the contribution of the estimation model of these phenomena, valid for mountain watersheds.
- The GEF project Sustainable Forest Management in the Transboundary Gran Chaco Americano, whose objective was to reverse the land and forest degradation trend in the Gran Chaco Americano by supporting sustainable land management in the productive sphere.
- The project for the implementation of practices for the integrated management of the hydrographic basin of the Pantanal and Upper Paraguay basin, which considers in particular biodiversity degradation and conservation processes.

The following are the proposed strategic actions:

***Strategic action III.2.1
Soil recovery and erosion control***

This strategic action establishes the basis for generating a land conservation program

⁴ COBINABE (2010). Generación y transporte de sedimentos en la cuenca binacional del río Bermejo. Caracterización y análisis de los procesos intervinientes. 1st. Ed., p 230.

in the La Plata Basin, which results in compromises between the countries for control of environmental and economic impacts associated with erosion, and formulating adaptive measures to climate variability and change in order to mitigate the effects on water and land resources. It focuses on all activities designed to address erosion-sedimentation problems in important support basins (typically rivers), although this should be considered as a flexible criterion. While it is good to include and tend to all forms of erosion, is of special interest to treat erosion not caused by the anthropogenic causes (channel edge erosion, mass landslides, large-sized gullies), which can be mitigated (or accelerated) by anthropogenic actions.

Considering the trends of expansion of land use activities (which increase deforestation processes), climate variability and change, future relations should be projected according to the most widely accepted weather forecasts. Based on this information, control and mitigation measures for the problems identified should be proposed. These will establish the foundation for negotiations between countries in order to achieve gradual and accepted goals for implementing necessary measures.

Thus, it is proposed to deepen the knowledge on sediment production, transport, and deposits in the La Plata Basin, and to approve proposals to manage the buffer zones. It is hoped that programs will be implemented for land recovery and erosion control in critical areas: the upper basin of the Bermejo (AR, BO), the Pilcomayo (AR, BO, PY), the Pantanal area (BR, PY), Parana hydrographic region (AR, BR, PY, UY), the outskirts of Buenos Aires (AR) and San Pablo (BR), the areas around the Parana River reservoirs (AR, BR, PY), the Brazil-Paraguay border and the Argentina- Paraguay

border, in the Uruguay river (AR, BR, UY), Acaray River (PY) and Black River (BR, UY), and the Salado River (AR).

Finally, mathematical models must be developed that consider the behavior of the phenomena involved in the production (erosion), transport, and deposit of sediment, which serves as a guide for decision-making, including compliance with legal rules that exist in this regard. It seeks to lay the foundation for a soil conservation program in the Basin that establishes commitments between countries to control the socio-environmental and economic impacts associated with erosion. It also promotes closer links between land management and biodiversity.

To achieve this goal, it is proposed to carry out the following activities:

- To deepen knowledge about production, transport, and deposit of sediments in critical areas, with an evaluation of the type of sediment. Developing tools for management.
- Land remediation program and erosion control in critical areas. Implementation of management measures. Proposal for buffer zone management.

Strategic action III.2.2 Local conservation and sustainable land management

This strategic action focuses on the same problems as the previous action (Strategic Action II.2.1 Land remediation and erosion control), but with a different emphasis in terms of scale and scope of action. This strategic action will preferably deal with the mitigation of diffuse erosion effected by changes in land use and coverage on a local property scale, the level at

which decisions on land use and soil management are made privately, typically in agricultural production organizations. The erosion problem in these cases has its solution or mitigation in adopting systems for land use and management practices that generate tolerable soil erosion rates. Thus, it is hoped that the countries of the La Plata Basin have regulations that promote good management and soil and water conservation practices for designing and managing agricultural production systems. It proposes to complement the studies and current land use and cover maps in coordination with strategic action I.1.2 Expansion and integration of information systems, and to replicate and expand the Gran Chaco Americano project and enhance and develop management practices and soil conservation through the integrated management of priority watersheds, preferably seeking to mitigate diffuse erosion. It also proposes implementing a sustainability program in vulnerable regions, mountain areas, or those with a water deficit. Finally, the proposal is to develop mathematical models that consider the behavior of the phenomena involved in erosion production, transport, and sediment deposit, in order to guide decision-making processes, including compliance with legal regulations (also indicated in strategic action III.2.1 Land recovery and erosion control).

To achieve the objectives of this strategic action, it is necessary to implement education and training programs included in strategic area IV Education, communication, and public participation at all levels, as well as conduct knowledge dissemination and outreach on the issue. It also requires that modeling tools validated in local conditions be available to guide decision-making. In addition, these actions, in many cases, will require research and development, which is also part of other planned actions.

The proposed activities around this strategic action are:

- Update current land use and coverage maps, in coordination with strategic action I.1.2.
- Replicate and extend sustainability good practices from the Gran Chaco Americano project.
- Develop management and land conservation practices through integrated management of priority watersheds.
- Implement a sustainability program for vulnerable regions, mountain areas, or those with a water deficit.
- Link riparian forest management with that of aquatic ecosystems.

Component III.3: Environmental sanitation

This component refers to the problems with the greatest environmental impact in the La Plata Basin, caused by pollutants associated with agricultural, industrial, and mining activities and the deficiency or lack of basic sanitation (collection and treatment of domestic and industrial sewage, urban drainage, and solid waste).

The extent of the impact of discharges on the environment depends directly on the amount released and, indirectly, on the receptor water body flows. In the large regional rivers —especially the Parana, the Paraguay, and the Uruguay or the La Plata River itself— due to their heavy flows, pollution has relatively low impacts which are concentrated on the outskirts of the cities. However, their tributaries, with lighter flows, can suffer the impacts of pollution originating from the lack of basic sanitation,

which, therefore, leads to degradation in the quality of the transboundary water bodies.

The objective of this component and its strategic actions is to identify the transboundary issues caused by pollution and reduce its sources (organic, chemical, and solid waste). Also, considering the deficiency/lack of basic sanitation, it attempts to set reduction and recovery targets that can be agreed upon by the countries for control and mitigation. Consequently, this component presents two clearly defined strategic actions: one aims to reduce sources of pollutants and the other focuses on urban sanitation and health.

Regarding the use of agrochemicals in agricultural activity, the FAO International Code of Conduct on Pesticide Management⁵ serves as a good reference. The Santa Lucia River basin, a tributary of the La Plata and Uruguay rivers, defined measures to reduce diffuse inputs of phosphorus and the eutrophication of waters through responsible land use and management plans, by which the handling of fertilizers with phosphorus and the use and management of organic waste in the areas of milk production are regulated.

Under the GEF's Environmental Protection and Sustainable Development of the Guaraní Aquifer System project, which involved four of the five Basin countries, successful practices for agrochemical control and use in aquifer recharge areas were identified (SAP/GAS).

One of the contributions of the Framework Program in treating this problem is to cooperate with national institutions responsible for water quality and pollutant control in order to develop a regional knowledge

base under the CIC and to establish a set of common monitoring parameters and a protocol for water quality control. The Program worked on assessing water quality throughout the Basin, generated an inventory of pollution sources (both point and diffuse sources), and identified critical areas, creating recommendations for pollution management. In particular, for the Cuareim/Quarai Pilot Project, a sediment production model was implemented and, in the Confluence pilot project, a model of spill diffusion was implemented. In the Selva Misionera Paranaense priority project, a water erosion model was put forth to quantify erosion by basins and to define vulnerable areas in a specific priority watershed located upstream of the Itaipu dam.

The proposed strategic actions for this component are:

Strategic action III.3.1 **Reduction of pollution sources**

This strategic action aims to reduce pollution sources, one of the most prominent environmental impact issues in the La Plata River Basin, originated by the lack of control over organic, chemical, and solid waste caused by industrial, mining, and agriculture activity.

The use of agrochemicals (fertilizers, herbicides, insecticides, and fungicides) is an integral part of agricultural production technologies, in particular, in crop production in large areas, but they are also used in small-scale production systems. Among the main water pollutants in the Basin are nutrients, in particular phosphorus, the cause of cyanobacteria blooms. The principal origin of this nutrient is—in large part—ero-

⁵ FAO - Food and Agriculture Organization of the United Nations, *The International Code of Conduct on Pesticide Management*, Rome, 2014. Accessed at: http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/Code/CODE_2014Sep_ENG.pdf

sion and sedimentation, since its geochemical dynamics tends to be retained by soil particles, although other dissolved transportation mechanisms cannot be ruled out.

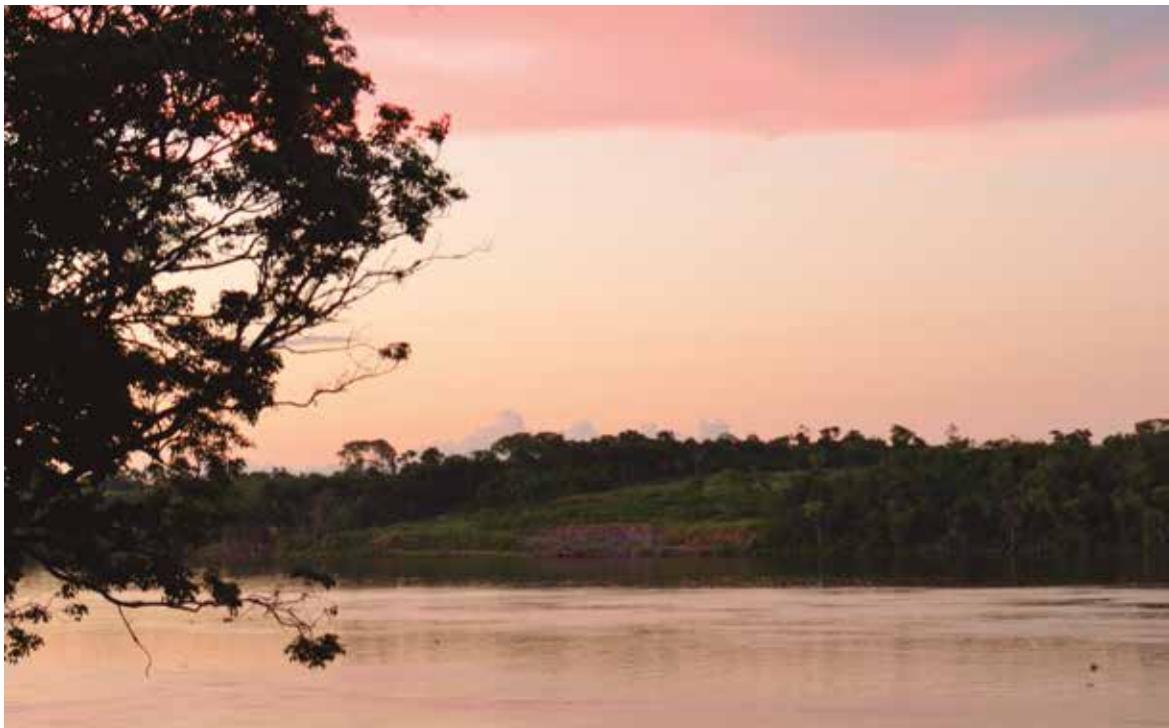
Among the principal agricultural chemicals are fertilizers, both synthetic and organic. Concerning the other agrochemicals (herbicides and pesticides), although there is no evidence that they have caused widespread generalized problems such as phosphorus eutrophication, they are also a cause of concern for the Basin countries.

For these reasons, it is necessary to pay attention to standards for fertilizing crops and other vegetation. It is recommended to apply good practices concerning nutrients used, the amount applied, and the method and timing of application. Herbicides and pesticides must also be used following rules and practices that minimize risk to water quality.

It is proposed to implement a joint solid waste and agrochemical management program. This will allow for the reduction of pollution by agricultural, industrial, and mining activity. In the long term, the implementation of a program for the joint risk management of agrochemicals, as well as organic nutrient sources is recommended.

The proposed activities for this strategic action include:

- Solid waste management program.
- Pollution reduction from industrial and mining activity.
- Reduction of agricultural pollution, including risk management from agrochemicals (fertilizers, herbicides, insecticides, and fungicides), as well organic nutrient sources.



Uruguay River.

Strategic action III.3.2
Urban sanitation and health

The objective of this component and its strategic action is to identify strategic trans-boundary issues caused by lack of basic sanitation and set recovery goals that can be agreed upon by all of the countries for their control and mitigation in order to improve the health of the population.

The implementation of this component and its strategic action requires that shared bodies of water in La Plata Basin be diagnosed with the degradation problems caused by the lack of basic sanitation. The problems should be future projections, considering the different scenarios established by global climate change models adopted by the Framework Program. Based on this diagnosis and prognosis, impact control and mitigation measures should be proposed through basic sanitation programs to be agreed upon by all

of the countries, with targets also agreed upon by all parties.

In the short term, it proposes that drinking water be stored in critical urban areas, considering climate change adaptation measures and alternatives for the protection of urban aquifers. In the medium term, the goal is to achieve universal treatment of urban effluents in the Basin. Finally, the long-term goal is to establish health plans associated with the treatment and mitigation of waterborne illness. The following activities have been proposed to deal with this problem.

- Safe water supply program in disadvantaged areas, considering climate change adaptive measures and alternatives for aquifer protection.
- Urban water management.
- Health plans related to the treatment and mitigation of waterborne illness.

Table 5

Strategic Area III - Components - Strategic actions – Activities

STRATEGIC AREA III: ENVIRONMENTAL PROTECTION / REHABILITATION

COMPONENT: III.1 Ecosystem Management

STRATEGIC ACTION: III.1.1 Conservation and expansion of protected areas and sustainable management of riparian and wetland ecosystems

- Managing the most significant threats to protected areas and wetlands, with an emphasis on Ramsar sites, considering shared prevention and mitigation guidelines, emphasizing mining and hydrocarbon exploration.
- Shared guidelines for the prevention, mitigation, and connecting of transboundary protected areas. Inventory the Pampa biome. Promote integrated environmental management in the parks of the Foz do Iguacu region between Brazil and Argentina, the river section Itaipu-Yacyreta on the Parana River, the stretch of river between Foz do Chapecó and Salto Grande on the Uruguay River, and in the re-charge areas of major transboundary aquifers (Guarani, Yrenda-Toba-Tarijeño, Pantanal, etc.).
- Recovery and adaptation of the teachings of the Cultivating Good Water program and other successful initiatives surrounding the conservation/rehabilitation of ecosystems, environmental management, and recovery of threatened species, wherever possible, with an emphasis on the active participation of local communities.
- Conservation and restoration of riparian and wetland ecosystems, with the creation and/or consolidation of forest, ecological, river, and coastal corridors and transboundary protected areas. Identification of endemic and endangered species. Priority will be given to conservation and sustainable biodiversity use and the protection of threatened species, habitats, vulnerable ecosystems such as riparian forests, and ecological wealth, taking into consideration the cultural traditions of indigenous peoples and local communities.

STRATEGIC ACTION: III.1.2 Management of aquatic and other associated ecosystems

- Management of aquatic resources. To update and characterize the inventories of species, breeding grounds and nurseries, with an emphasis on the presence of invasive, exotic, and non-native species in basins and sub-basins. Consider in particular endangered species.
- Develop a cross-border strategy for the control and management of invasive, exotic, and non-native aquatic species, especially in the Upper Parana dams, and in the La Plata-Parana-Paraguay-Pantanal river axis, in conjunction with strategic action II.2.2.
- Proposal for operating hydraulic works for the protection of fishable stock, in conjunction with strategic action II.2.2.
- Expansion and replication of the pilot project for the Conservation of Biodiversity in regulated areas.

Strategic Area III – Components – Strategic actions – Activities (cont.)

STRATEGIC AREA III: ENVIRONMENTAL PROTECTION / REHABILITATION

COMPONENT: III.2 Sustainable Land Management

STRATEGIC ACTION: III.2.1 Land recovery and erosion control

- To deepen knowledge about production, transport, and deposit of sediments in critical areas, evaluating the type of sediment. Developing tools for management.
- Land remediation program and erosion control in critical areas. Implementation of management measures. Proposal for buffer zone management.

STRATEGIC ACTION: III.2.2 Local conservation and sustainable land management

- Update current land use and coverage maps, in coordination with strategic action I.1.2.
- Replicate and extend sustainability good practices from the Gran Chaco Americano project.
- Develop management and land conservation practices through integrated management of priority watersheds.
- Implement a sustainability program for vulnerable regions, mountain areas, or those with a water deficit.
- Link riparian forest management with that of aquatic ecosystems.

COMPONENT: III.3 Environmental Sanitation

STRATEGIC ACTION: III.3.1 Reduction of pollution sources

- Solid waste management program.
- Pollution reduction from industrial and mining activity.
- Reduction of agricultural pollution, including risk management from agrochemicals (fertilizers, herbicides, insecticides, and fungicides), as well as organic nutrient sources.

STRATEGIC ACTION: III.3.2 Urban sanitation and health

- Safe water supply program in disadvantaged areas, considering climate change adaptive measures and alternatives for aquifer protection.
- Urban water management.
- Health plans related to the treatment and mitigation of waterborne illness.

STRATEGIC AREA IV. EDUCATION, COMMUNICATION, AND PUBLIC PARTICIPATION

This area is transverse to all of the strategic areas, since it essentially is made up of instruments adopted by countries for sustainable development and management. It has the political support of Mercosur since 2001, by way of the Framework Agreement on the Environment. It involves participatory actions aimed at improving education, training, and communication in the La Plata Basin in order to develop the capacity of society to address/solve the CTIs in a participatory manner.

This area addresses components and strategic actions that aim to educate, raise awareness, train, disseminate information, keep accountable, and prepare society so that improved (efficient and effective) social participation may be established in solving problems of interest to the Framework Program. Given these challenges, most of the results will be visible only in the medium- and long-term, but should be part of a program that notes the transformation of the reality of the Basin —economic, environmental, social, and cultural— with social actors as the protagonists.

With these aspirations, three strategic actions are proposed, each one associated with the key topics in the area: education, training, communication, and public participation.

Through education, these actions aim to raise awareness about the problems and stimulate the adoption of appropriate sustainable development practices. Through training and rural extension, it aims to train water and land users in rural areas to implement sustainable actions. And finally, by way of communication and public par-

ticipation, it proposes to disseminate relevant information about the problems facing the Basin, providing support to the programs and promoting available participation outlets. Therefore, this strategic area deals with relations between the Framework Program and civil society and has been demonstrated through the pilot projects developed under the project framework and the replication of the Cultivating Good Water project and the Public Participation Fund sub-projects.

Component IV.1: Environmental Education

Strategic Action IV.1.1

Environmental education program

This strategic action proposes to develop and implement an education and citizen awareness program on sustainable development issues in the context of climate variability and change, prepared in each country based on minimum content protocol established for the LPB region. This program will focus on socio-environmental issues such as sanitation, sustainable use of aquifers, risk prevention and mitigation, emergency response, natural disaster contingencies, environmental hygiene and health, fishing communities and fish farmers with sustainable and responsible techniques, and sustainable tourism, that encourages social participation in the implementation of activities. It will promote the use of pedagogical criteria adapted to the social and topical context of each country.

The activities planned under this strategic action include:

- The promotion and coordination of national programs for environmental education and citizen awareness according to the geographical, topical, cultural

and curricular conditions of each country. Particular attention will be given to developing programs related to the topic of water resource management and sustainable development, as well as issues selected from the CTIs, including sustainable use of aquifers and wetlands, risk prevention and mitigation in the face of emergency, natural disaster contingency, natural hazards, sustainable tourism, sanitation, hygiene, and health.

- Development of teaching materials at all levels and for all age groups, in particular referring to the prevention and mitigation of environmental risk.
- Promotion of formal and non-formal environmental education using practices that are participatory and inclusive of socio-environmental topics.
- Generation of educational processes and creation of citizen funds for civil society inclusion.

Strategic action IV.1.2
Training and rural outreach program

This strategic action includes programs for training, outreach, and awareness in water resource management practices, ensuring IWRM and land conservation. These must focus on topics related to native fish-farming operation and sustainable fishing and farming, forestry, and mining techniques, mining the local knowledge and sustainable practices of each country where necessary.

Training programs should be developed based on the needs of LPB border areas that have land and water degradation problems as a result of agricultural and mining activities. They should present land management and conservation practices, native

fish-farming and sustainable fishing techniques, and sustainable farming, forestry, and mining techniques, recovering the local knowledge and sustainable practices of each country where necessary. In addition, it proposes to guide the development and dissemination of sustainable technologies to increase the availability and efficient use of surface and underground water irrigation.

Through training programs, opportunities for sustainable development will be generated by promoting innovative ventures. Emphasis will be placed on training younger generations.

This program is considered to be permanent and, therefore, its execution must have long-term continuity.

The activities planned under this strategic action include:

- Promotion of training, outreach, and awareness programs in land management and conservation practices, in native fish farming and sustainable fishing techniques, and in sustainable agriculture, forestry, and mining techniques, recovering the local knowledge and sustainable practices of each country and the participation of stakeholders like universities, among others.
- Development and dissemination of sustainable technologies to increase the availability and efficient use of surface and underground water irrigation.
- Rural outreach programs using efficient techniques, appropriate for the geography, culture, and socioeconomic context.
- Generation of permanent learning circles and the creation of strategic alliances.

Component IV.2: Communication and Public Participation

This component proposes a communication program for IWRM in the La Plata Basin.

Strategic action IV.2.1

Social communication and public participation program to promote awareness and social participation

This action proposes to carry out an awareness, communication, and public dissemination program adapted to the different national, regional, and social realities in order to promote water management and sanitation, particularly in contingency plans, especially those relating to extreme events and critical transboundary issues in the LPB.

The communication program should be the means to inform society in general of the environmental situation in the LPB, and in particular about the effects of climate variability and change in the physical and socioeconomic realms.

The activities planned under this strategic action include:

- Promoting awareness, communication, and public dissemination programs to address problems linked the CTIs in the LPB with a comprehensive vision of the basin, and aimed at deepening knowledge of possible impacts and adaptive responses to global climate change. It is a replica of the Cuareim/Quaraí and Confluence Pilot Project communication experiences.
- Promoting programs to communicate and disseminate contingency plans for critical events (regional and local).
- Promoting public participation programs for local communities in water management and sanitation.
- Design and production of communications content in different formats. Collection and processing of information related to the activities of the Framework Program that translate into accessible material for target audiences.

Table 6

Strategic Area IV – Components – Strategic actions – Activities

STRATEGIC AREA IV: EDUCATION, COMMUNICATION, AND PUBLIC PARTICIPATION

COMPONENT: IV.1 Environmental Education

STRATEGIC ACTION: IV.1.1 Environmental Education Program

- The promotion and coordination of national programs for environmental education and citizen awareness, according to the geographical, topical, cultural, and curricular conditions of each country. Particular attention will be given to developing programs related to the topic of water resource management and sustainable development, as well as issues selected from the CTIs, including sustainable use of aquifers and wetlands, risk prevention and mitigation in the face of emergency, natural disaster contingency, natural hazards, sustainable tourism, sanitation, hygiene, and health.
- Development of teaching materials at all levels and for all age groups, in particular referring to the prevention and mitigation of environmental risk.
- Promotion of formal and non-formal environmental education using practices that are participatory and inclusive of socio-environmental topics.
- Generation of educational processes and creation of citizen funds for civil society inclusion

STRATEGIC ACTION: IV.1.2 Training and Rural Outreach Program

- Promotion of training, outreach, and awareness programs in land management and conservation practices, in native fish farming and sustainable fishing techniques, and in sustainable agriculture, forestry, and mining techniques, recovering the local knowledge and sustainable practices of each country and the participation of stakeholders like universities, among others.
- Development and dissemination of sustainable technologies to increase the availability and efficient use of surface and underground water irrigation.
- Rural outreach programs using efficient techniques, appropriate for the geography, culture, and socio-economic context.
- Generation of permanent learning circles and the creation of strategic alliances.

COMPONENT: IV.2 Communication and Public Participation

STRATEGIC ACTION: IV.2.1 Social communication and public participation program to promote awareness and social participation

- Promoting awareness, communication, and public dissemination programs to address problems linked the CTIs in the LPB with a comprehensive vision of the basin, and aimed at deepening knowledge of possible impacts and adaptive responses to global climate change. It is a replica of the Cuareim/Quaraí and Confluence Pilot Project communication experiences.
- Promoting programs to communicate and disseminate contingency plans for critical events (regional and local).
- Promoting public participation programs for local communities in water management and sanitation.
- Design and production of communications content in different formats. Collection and processing of information related to the activities of the Framework Program that translate into accessible material for target audiences

STRATEGIC AREA V. RESEARCH AND TECHNOLOGICAL DEVELOPMENT

This strategic area meets the demand presented by the TDA concerning the development of research and technology to be applied to solving the Critical Transboundary Issues. It aims to promote the reallocation of resources based on necessary technological developments to promote the sustainable management of water resources.

Thus, depending on the demands of the various thematic areas, it proposes to promote exchanges related to technical and scientific development on issues related to solving the Basin's CTIs, seeking to fill information gaps identified in the Framework Program and to develop appropriate approaches and technologies (efficient and effective).

To this end, it presents a unique strategic action, aimed at supporting and promoting research, technological development, and innovation for generating information and technologies relevant to the treatment of prioritized Critical Transboundary Issues.

Component V.1: Research and Technological Development

Strategic action V.1.1.

Support research development, technological development, and innovation associated with the CTIs

This strategic action includes developing research and technologies to be applied to solving critical transboundary issues covering several problems and areas of knowledge: the vulnerability of coastal habitats, erosion, generation and transport of sediment, the ratio of groundwater to surface water (integrated water balance), ecological flow, integrated and participatory watershed management, technologies to increase the availability and efficient use of water for irrigation and environmental sanitation and health.

The activities planned under this strategic action include:

- Promote the implementation of research programs, integrating government entities, productive sectors, scientific organizations, and civil society representatives to identify vulnerabilities, to create impact scenarios, and to formulate adaptation strategies and policies.
- To influence the agendas of national and multinational research agencies on topics of interest and for postgraduate scholarships.
- Promotion and coordination of regional research networks for horizontal cooperation and exchanging experience.
- Interact with national research agencies to explore the possibilities for including LPB topics in their agendas.

Table 7

Strategic Area V - Components - Strategic Actions - Activities

Strategic Area IV: Research and Technological Development

COMPONENT V.1 Research and Technological Development

STRATEGIC ACTION: V.1.1 Support research development, technological development, and innovation associated with the CTIs

- Promote the implementation of research programs, integrating government entities, productive sectors, scientific organizations, and civil society representatives to identify vulnerabilities, to create impact scenarios, and to formulate adaptation strategies and policies.
- To influence the agendas of national and multinational research agencies on topics of interest and for postgraduate scholarships.
- Promotion and coordination of regional research networks for horizontal cooperation and exchanging experience.
- Interact with national research agencies to explore the possibilities for including LPB topics in their agendas.

STRATEGIC AREA VI. INSTITUTIONAL STRENGTHENING

Strategic area VI includes proposals for institutional and legal adjustments deemed necessary to facilitate SAP implementation.

From the institutional point of view, strategic area VI comprises i) strengthening the Intergovernmental Coordinating Committee of the Countries of the La Plata Basin; ii) strengthening participating national bodies' action on water resources and related areas; and iii) bringing them together, the adaptation of the relationship and procedures governing the interaction of the various participating institutions.

From a legal point of view, this area is interested in the harmonization of legal standards and setting common or compatible standards and protocols in the five countries for the purpose of greater uniformity of the fundamental principles which may facilitate the realization of the Framework Program's objectives and the SAP's strategic actions and activities.

Component VI.1: Institutional Framework

This component is aimed at resolving the weaknesses of the existing institutional framework to address critical transboundary issues, including actions for strengthening and institutional coordination to facilitate the integrated management of hydraulic resources throughout the Basin and guide the development processes into sustainable conditions. The strategic actions and activities planned are based on the institutional structure developed in Stage 1 of the Framework Program, where active participation of the five basin countries catalyzed efforts toward the joint management of the various topics of interest to the Basin, coordinated by the CIC.

The strategic actions and activities planned are as follows:

Strategic action VI.1.1 Strengthening the CIC as an organization for coordination and institutional linking for the purpose of SAP implementation

While the experience during Phase 1 of the Framework Program has been valuable, the SAP implementation stage will require strengthening the CIC, expanding its powers, and enhancing its technical and administrative resources, as well as adapting the instances of binational and regional coordination.

It proposes that the coordination of these organisms occur through agreements that are established and accompanied by the CIC through specific procedures. This would allow the CIC to operate as a facilitating agency regulating these agreements, among other powers. This also empowers not only the coordination between agencies with similar powers, but also among those with different functions but with the possibility of being affected by sectorial criteria.

The activities planned under this strategic action include:

- Strengthening regional and binational coordination in general and instances of approval in SAP management, including defining the respective protocols.
- Strengthening the methods of the CIC in relating to the agencies in the La Plata Basin System.
- Strengthening cooperation with other international institutions and promoting complementary agreements with similar institutions.

- Strengthening the technical and administrative structure of the CIC for SAP implementation.
- Establishing a methodology to assess the technical, financial, budgetary, and administrative elements of SAP implementation.

Strategic action VI.1.2

Strengthening national agencies involved in the binational or regional coordination of the SAP implementation stage

This strategic action includes strengthening the various national bodies with responsibilities in the management of shared water resources based on the new needs, addressing the weaknesses and institutional requirements for managing agencies competent in relation to the Critical Transboundary Issues within the framework of climate variability and change.

These agencies include: weather and agro-meteorological forecasting services; geological services; surface and groundwater resource management agencies; organizations in charge of the operation, administration, and control of waterworks, waterways, hydroelectricity, and sanitation systems; technological development agencies, etc.

Strengthening actions for national agencies will focus on covering needs in relation to the implementation of the SAP and the incremental costs required to support regional action. Above this level, the strengthening demands must be met with compensatory resources.

The activities planned under this strategic action include:

- General conceptualization and identification of the baseline and organizational strengthening needs for treating the CTIs throughout the Basin.
- Strengthening the relationship between the CIC and agencies managing water and environment, geological and meteorological services, navigation, hydro-power, sanitation, production, and services both nationally and regionally.
- Establishment of cooperation mechanisms to facilitate national and inter-governmental cooperation in priority areas with improved use of existing intergovernmental forums.

Component VI.2: Legal Framework

This component has two strategic actions which consider the adaptation and harmonization of national legal frameworks related to the joint management of shared water resources in La Plata Basin.

The need for this component and its strategic actions arises from the confirmation that, in order to address several of the cross-border problems, there is a need for the countries to establish joint regulations—or at least compatible ones—to replace the ones that are conflicting.

An example typically found in the environmental area is the verification that protocols on ballast water and invasive species must be homogeneous for them to be effective in controlling environmental impacts.

The need for compatibility should start off with topics featured in the TDA, for example: standards for water quality classification, codes and standards for commercial and sport fishing, river transport regulations, protocols related to exotic species, ballast water standards, well-drilling regulations, standards for managing water use in shared basins, as well as regulations for the safety and operation of hydraulic structures in emergency situations.

The strategic actions are:

Strategic action VI.2.1

Harmonization of national legal frameworks for transboundary water resource management, including agreements between countries as well as adaptations of national legislation

Promotes agreements between countries as well as adaptations of national legislation to enable a uniform legal framework.

The activities planned under this strategic action include:

- Harmonization of public policy frameworks and regulations for their implementation in the different member countries to improve the management of water resources.
- Promotion of inter-state agreements, guidelines, and framework regulations for managing transboundary water resources in each of the countries to harmonize regional policies, considering, among other things: sustainable aquifer use, construction and use of wells, adoption of common emergency security and operation protocols, river transport and fishing in shared waters.
- Formalize international legal instruments on identified transboundary protected areas: the tri-national Pantanal, Gran Chaco tri-national corridor, and the Ñeembucú binational corridor.
- Create protocol for coordinating with the various national legislatures for managing instruments.

Strategic action VI.1.2

Developing common technical guidelines and protocols for actions aimed at enabling the management of shared hydraulic resources

Includes regulations that are “under the law” and refers to establishing common or compatible regulations, protocols, and standards to facilitate the implementation of SAP actions.

This strategic action includes:

- Harmonization of procedures and guidelines for water user registries, water use grants, and environmental licenses (exchange of methodologies and development of guides and common protocols).
- Promoting agreements and technical guidelines for managing water use in priority watersheds, for harmonizing regional policies for river transport, and for adopting common security and emergency operation protocols.
- Living aquatic control mechanisms, binational or tri-national monitoring, involving agreements with binational hydroelectric plants.
- Harmonization of protocols and development of agreed-upon criteria for water quality evaluation and monitoring, for fishing regulations—including consolidating sport fishing standards in the sub-basins— and for ballast water to control invasive species.
- Creation of joint protocols for managing agrochemicals and promoting the use of biopesticides.

Both strategic actions correspond to different projects. While the first corresponds to a comprehensive project, the second plans for a general methodological development, while particular developments will be included in the corresponding thematic or sectoral areas, integrating sectoral technical aspects and legal approaches.

Table 8

Strategic Area VI – Components – Strategic actions – Activities

STRATEGIC AREA VI Institutional Strengthening

COMPONENT: VI.1 Institutional Framework

STRATEGIC ACTION: VI.1.1 Strengthening the CIC as an organization for coordination and institutional linking for the purpose of SAP implementation

- Strengthening regional and binational coordination in general and instances of approval in SAP management, including defining the respective protocols.
- Strengthening the methods of the CIC in relating to the agencies in the La Plata Basin System.
- Strengthening cooperation with other international institutions and promoting complementary agreements with similar institutions.
- Strengthening the technical and administrative structure of the CIC for SAP implementation.
- Establishing a methodology to assess the technical, financial, budgetary, and administrative elements of SAP implementation.

STRATEGIC ACTION: VI.1.2 Strengthening national agencies involved in the binational or regional coordination of the SAP implementation stage

- General conceptualization and identification of the baseline and organizational strengthening needs for treating the CTIs throughout the Basin.
- Strengthening the relationship between the CIC and agencies managing water and environment, geological and meteorological services, navigation, hydropower, sanitation, production, and services both nationally and regionally.
- Establishment of cooperation mechanisms to facilitate national and intergovernmental cooperation in priority areas with improved use of existing intergovernmental forums.

COMPONENT: VI.2 Legal Framework

STRATEGIC ACTION: VI.2.1 Harmonization of national legal frameworks for transboundary water resource management, including agreements between countries as well as adaptations of national legislation

- Harmonization of public policy frameworks and regulations for their implementation in the different member countries to improve the management of water resources.
- Promotion of inter-state agreements, guidelines, and framework regulations for managing transboundary water resources in each of the countries to harmonize regional policies, considering, among other things: sustainable aquifer use, construction and use of wells, adoption of common emergency security and operation protocols, river transport and fishing in shared waters.
- Formalize international legal instruments on transboundary protected areas, among other things.

STRATEGIC AREA VI Institutional Strengthening

STRATEGIC ACTION: VI.2.2 Developing common technical guidelines and protocols for actions aimed at enabling the management of shared hydraulic resources

- Harmonization of procedures and guidelines for water user registries, water use grants, and environmental licenses (exchange of methodologies and development of guides and common protocols).
- Promoting agreements and technical guidelines for managing water use in priority watersheds for the harmonization of regional policies for river transport and for adopting common security and emergency operation protocols.
- Living aquatic control mechanisms, binational or tri-national monitoring, involving agreements with binational hydroelectric plants.
- Harmonization of protocols and development of agreed-upon criteria for water quality evaluation and monitoring, for fishing regulations—including consolidating sport fishing standards in the sub-basins—and for ballast water to control invasive species.
- Creation of joint protocols for managing agrochemicals and promoting the use of biopesticides.



Ibera estuaries in Argentina.



Chapter 5:

Final Considerations and Foundations for Implementing the SAP

The Strategic Action Program (SAP) was designed as an instrument for coordinating policies for water resource management and related environmental issues, in the context of present challenges as well as future problems related to climate variability and change in the La Plata Basin. The SAP has a long-term vision and considers the Critical Transboundary Issues identified to be barriers to overcome in order to promote sustainable development.

The program is the result of the consolidation of numerous studies and programs developed to characterize the current and emerging Critical Transboundary Issues, their main causes and impacts and projections that present different scenarios of climate variability and change. These works—because they have been carried out with the active involvement of authorities in each country from different government institutions, specialties, and academia in the fields of water resource management, environment, and climate—lay the groundwork for future joint implementation of national and regional policies within the institutional framework of the CIC as the coordinator and implementer of actions throughout the Basin.

This La Plata Basin SAP has a planning horizon of 20 years, it includes six (6) strategic areas, 13 components, and 28 strategic actions. The strategic areas detailed in *Chapter 4* of this document are: i) Information management; ii) Planning, management, and sustainable use of water resources; iii) Environmental protection/rehabilitation; iv) Education, communication, and public participation; v) Research and technological development; and vi) institutional strengthening. The set of strategic actions and the 130 activities that make them up constitute the intervention response and management recommendations to solve or mitigate the impacts of the major Critical Transboundary Issues that affect the Basin (based on the analysis of the causes identified) and to promote sustainable development. While the environmental, social, and economic impacts of each one of these actions can be differentiated, together they are aimed at resolving issues relevant to an area or region, and/or to move forward in solving critical issues in the Basin in general.

For SAP implementation, a programmatic approach is suggested. With this approach, strategic areas or specific components may

be simultaneously developed and executed, dealing with particular issues (hydro meteorological monitoring and alert, water supply, ecosystem management, reduction of pollution sources, etc.). The timing and implementation schedule of these actions within the framework of the program as a whole will depend on obtaining the funding needed for implementation. In the short term, the priority is to seek funding for the implementation of selected projects in each of the strategic areas, addressing the most important aspects identified to solve critical issues in the Basin, catalyzing the production of new sources of funding that invigorate the implementation of the other SAP actions.

A necessary condition for SAP implementation is the participation of numerous institutions and organizations with natural resource management competencies. Based on the political organization (unitary or federal) of the Basin countries and the powers delegated to the various jurisdictions under their respective constitutions, active participation of provincial, departmental, and state authorities in coordination with relevant national institutions for the development and implementation of program proposals is expected.

Also, depending on the scale of the intervention to be performed, entities will be involved at the municipal level: non-governmental organizations, community or-

ganizations and businesses, producer and consumer associations, and academic and research institutions, among others. The proposed actions will be implemented in each country according to the execution structure that each one has set for program implementation.

The SAP strategic actions include various territorial areas, covering in some cases the entire Basin and in other cases specific areas located in certain sub-basins, including both individual states and provinces, such as regions that spread across several countries. And the scope of the intervention will be different as well, as will the diverse agencies and institutions in charge of executing the actions. The multiplicity of actors involved in the implementation of actions—each with their own timetables, priorities, interests, and mechanisms—raises the need to establish an organizational framework to facilitate the articulation, functionality, and sustainability of the program.

In this regard, a priority action is the development of an institutional framework and the harmonization of legal frameworks as essential tools for coordinating the program's strategic actions, taking into account the regional nature of its objectives and encouraging the participation of the different local actors appointed nationally through representatives from each country and at the regional level under the CIC.

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Appendix

- Table 9 Institutions that participated in Phase 1 of the Framework Program

List of acronyms

AOP	Annual Operating Program
APR	Annual Progress Report
AUGM	Montevideo Association of Universities
BD	Board of Directors of the Project
CEREGAS	Center for Groundwater Management
CIC	Intergovernmental Coordinating Committee of the Countries of the La Plata Basin
CPRM	Geological Survey of Brazil
CRC-SAS	Regional Climate Center for Southern South America
DSS	Decision-making Support System
FONPLATA	La Plata Basin Financial Development Fund
FP	The Framework Program for the Sustainable Management of La Plata Basin's Water Resources, with respect to the effects of climate variability and change
FPP	Fund for Promoting Public Participation
GEF	Global Environment Fund
GS/CIC	General Secretariat of the Intergovernmental Coordinating Committee of the Countries of the La Plata Basin
GS/OAS	General Secretariat of the Organization of American States
IBA	Important Bird and Biodiversity Area
ISARM	International Shared Aquifer Resource Management
IWRM	Integrated Water Resource Management
LPB	La Plata Basin
OAS	Organization of American States
NC	National Coordinator
NPU	National Project Unit
PCU	Project Coordination Unit
PD	Project Direction
PIP	Project Implementation Plan
SAP	Strategic Action Plan
SIAM	Mercosur Information System
SRHU	Secretary of Urban Environment and Water Resources of Brazil (SRHU)
TDA	Transboundary Diagnostic Analysis
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
YTTAS	Yrenda-Toba-Tarijeño Aquifer System

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Pág. 22	Waterfalls	S. Mogliati
Pág. 25	Corá Hills	Secretary of Environment of Paraguay
Pág. 29	Paraná River	Ministry of Environment of Brazil
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National Units of the Framework Program

Thematic Groups of the Framework Program

Argentina*	Bolivia	Brazil	Paraguay	Uruguay
Legal and Institutional Framework				
Ministry of Foreign and Religious Affairs (Mónica Troadello, Natalio Marcelo Jamer)	Ministry of Foreign Affairs (Juan Carlos Alurralde, Pablo Guzmán Lougier, Mayra Montero Castillo)	Ministry of Foreign Affairs (Eugenia Barthelmeß, Joa Luiz Pereira Pinto); Ministry of the Environment/ Secretariat of Water Resources and Urban Environment (Julio Thadeu Silva Kettelhut)	Ministry of Foreign Affairs (Didier Olmedo, Luis Fernando Avalos, Blas Felip)	Ministry of Foreign Affairs (Juan Antonio Remedi)
Decision-making Support System				
Sub-secretariat for Water Resources de la Nación (Federico Scuka, Carla Lupano)	Ministry of Water and Environment (Lizet Sullcata)	National Water Agency (Sergio Barbosa)	Secretariat of the Environment (Julián Cáceres); Faculty of Engineering at the National University of Asunción (Federico Ferreira, Nestor Cabral)	Ministry of Housing, Land Use and Environment (Virginia Fernández); Instituto Uruguayo Meteorología (NUMET) (Víctor Marabotto); Comisión Técnica Mixta de Salto Grande (CTM-SG) (Ignacio Corrales)
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The GEF promotes international cooperation and fosters actions to protect the environment of our planet. Since its inception, it has become a catalyst and source of funding to consider global environmental issues in the development process in an integrated way, which is crucial to achieving a sustainable balance between man and nature. It provided the grants which funded the Framework Program.



UNITED NATIONS ENVIRONMENT PROGRAMME – UN ENVIRONMENT

UN Environment directs and encourages participation in caring for the environment by inspiring, informing and giving nations and peoples the means of improving their quality of life without endangering future generations. In the organizational structure of the Framework Program, it has been the GEF implementing agency, and its goal has been to ensure that the project is implemented for the benefit of the global environment. Member of the Project Board.



Organization of
American States
More rights for more people

ORGANIZATION OF AMERICAN STATES – OAS

The OAS has maintained a historical relationship of technical cooperation with the La Plata River Basin and the CIC on issues related to sustainable development, natural resources and management of water resources. For the preparation of the Framework Program for the La Plata Basin, it was the regional organization selected both by UN Environment and by the CIC, as the executing agency with technical and administrative responsibility for GEF funds. Member of the Project Board.

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Aliene Zardo Ferreira (2011)
Danielle Carvalho (2011–2012)
Lourdes Martins (2012–2015)
María Paula Giorgieri (2015–2016)

Publications of the Framework Programme

Main Documents

Versions in Spanish, Portuguese and English



Transboundary Diagnostic Analysis of the La Plata Basin TDA



Strategic Action Program for the La Plata Basin SAP



Transboundary Diagnostic Analysis (TDA) and Strategic Action Program (SAP) of the La Plata Basin Executive Summary



Framework Program of the La Plata River Basin Implementation Process and Primary Outcomes

Thematic Documents



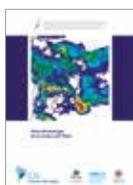
Sistema soporte para la toma de decisiones de la Cuenca del Plata



Marco institucional y legal para la gestión integrada de los recursos hídricos en la Cuenca del Plata



Participación pública, comunicación y educación
Proyectos del Fondo de Participación Pública
Réplica del Programa Cultivando Agua Buena



Hidroclimatología de la Cuenca del Plata



Balance hídrico en la Cuenca del Plata
Disponibilidad y usos, considerando escenarios futuros
Modelos de gestión



**Calidad del agua
en la Cuenca del Plata**



**Aguas subterráneas
en la Cuenca del Plata**



**Ecosistemas acuáticos
en la Cuenca del Plata**



**Inventario de Regiones
de Humedales de
la Cuenca del Plata**



**Degradación de tierras
en la Cuenca del Plata**



**Selva Misionera
Paranaense**



**Hidroelectricidad
y navegación en
la Cuenca del Plata**



**Oportunidades
de desarrollo sostenible
en la Cuenca del Plata**



**Buenas prácticas
en el uso del suelo
en la Cuenca del Plata**



**Boas práticas
para o cultivo do arroz
na Bacia do Prata**



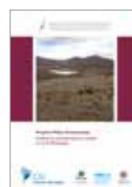
**Proyecto Piloto Demostrativo
Conservación de la biodiversidad
íctica en una zona regulada
del río Paraná**



**Proyecto Piloto Demostrativo
Conflictos de uso del agua en la
cuenca del río Cuareim/Quaraí**



**Proyecto Piloto Demostrativo
Sistema de alerta hidroambiental
en la confluencia de los ríos
Paraguay y Paraná**



**Proyecto Piloto Demostrativo
Control de contaminación
y erosión en el río Pilcomayo**



The Framework Program for the Sustainable Management of La Plata Basin's Water Resources, with respect to the effects of climate variability and change



CIC
Cuenca del Plata



GLOBAL ENVIRONMENT
FACILITY



United Nations
Environment Programme



Organization of
American States
Más rights to more people