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ON A

GRANT

IN THE AMOUNT OF
(US$ 13.40 MILLION EQUIVALENT)

TO

ARGENTINA, BRAZIL, PARAGUAY AND URUGUAY

FOR THE

ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT OF THE GUARANI AQUIFER SYSTEM PROJECT

July 30, 2009

Sustainable Development Department
Brazil Country Management Unit
Latin America and the Caribbean Region

CURRENCY EQUIVALENTS

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ABBREVIATIONS AND ACRONYMS

BGR	*Bundesanstaltfuer Geowissenschaften und Rohstoffe (BGR)* -- Federal Institute for Geosciences and Natural Resources ("German Geological Survey")
BNWPP	Bank-Netherlands Water Partnership Program
CASs	Country Assistance Strategies
CPS	Country Partnership Strategy
ERR	Economic Rate of Return
FMR	Financial Management Reports
GAS	Guaraní Aquifer System
GEF	Global Environment Fund
GEO	Global Environment Objectives
GW	Groundwater
GWMATE	Groundwater Management Team
IAEA	International Atomic Energy Agency
IEG	Independent Evaluation Group
IRR	Internal Rate of Return
IW	GEF International Water Program
LCR	Latin America and the Caribbean Region
M&E	Monitoring and Evaluation
MTR	Mid-Term Review
NCs	National Coordinators
NGOs	Non-Governmental Organizations
NPEU	National Project Execution Units
NPV	Net Present Value
OAS	Organization of American States
OP	Operational Policy
PAD	Project Appraisal Document
PDO	Project Development Objective
PS	Project Secretariat
SAP	Strategic Action Program
SC	Steering Committee
SDR	Special Drawing Rights
SISAG	GAS Information System (SISAG - *Sistema de Información del Sistema Acuífero Guaraní*)
TA	Technical Assistance
TDA	Transboundary Diagnostic Analysis

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COUNTRY
Project Name

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1. Project Context, Global Environment Objectives and Design

(this section is descriptive, taken from other documents, e.g., PAD/ISR, not evaluative)

1.1 Context at Appraisal *(brief summary of country and sector background, rationale for Bank assistance)*

1.1.1 The Guarani Aquifer System (GAS) is an important groundwater resource that is shared by Argentina, Brazil, Paraguay and Uruguay. For these four countries, groundwater, especially deep aquifers, constitute a strategic reserve for water supply in the face of increasing scarcity and pollution of surface water sources. However, what was known about the extent of the GAS; levels of extraction, recharge and discharge; vulnerability to pollution and contamination; and the transboundary impact was very limited and thus available knowledge was preliminary. There was a general belief that the Guarani aquifer was faced with threats stemming from uncontrolled abstraction, and pollution in the extraction and recharge areas. In addition, the prevalent thought was that the resource had the potential to be a source of contention among the countries since it was believed that the use of the aquifer by one country would be at the expense of the other riparian countries.

1.1.2 Based on the limited knowledge available, the Project Appraisal Document (PAD; p.5) argued that at the rate of use prevalent during project preparation and "considering the growing use of groundwater for human consumption, it is easy to foresee an increasing threat of pollution and depletion in the not too distant future. Uncontrolled use, without rules or regulation, can alter the status of the [GAS] from that of a strategic reserve of drinking water to that of a degraded waterbody that is the source of conflict among the countries." Therefore, this GEF supported Environmental Protection and Sustainable Management of the Guarani Aquifer System Project (the Guarani Project) was designed as a first step towards a long-term objective of sustainable, integrated management and use of the GAS. The Project was the first regional groundwater-related undertaking of the four countries and was preventive, not only from the standpoint of forestalling overexploitation, pollution and contamination, but also before disagreement among the countries became a reality and turned to the worst.

1.1.3 The Country Assistance Strategies (CASs) and the fragmented approaches in the four countries recognized the need for sustainable management of their water resources. Direct linkage to the Guarani aquifer was made in the CAS for Brazil, which identified the aquifer and its management as important for the country in terms of providing or potentially providing water for domestic and industrial purposes to more than 500 municipalities in eight states. The Argentina CAS mentions serious water quality problems due to aquifer "mining" and vertical contamination. Although the CASs for Paraguay and Uruguay attached importance to water resource management, linkage to the Guarani aquifer was not made. The PAD described specific water sector issues included in the CASs for the four countries[1]-- issues that have bearings on the management of the water resources as they relate to each country.

1.1.4 The general sector issue related to groundwater (GW) management and specific to the GAS was a general lack of information and weak administrative mechanisms in all four countries.

1 The four CAS discussed by the PAD include: (i) Argentina: CAS. 2000. Report # 20345-AR; (ii) Brazil: CAS. 2000. Report # 20160-BR; (iii) Paraguay: CAS. 1997. Report # 16346-PA; and Uruguay: CAS 2000. Report # 20355-UR.

1.1.5 The Bank's experience in implementing a large number of water projects and long-standing policy dialogue regarding different aspects of water management in each of the four countries was identified in the PAD as the rationale for Bank's involvement. Also, the Bank was a leading agency in implementing GEF International Water (IW) projects that resulted in developing a considerable in-house expertise and internationally-based knowledge of the main issues relating to such initiatives.[2]

1.2 **Original Global Environment Objectives (GEO) and Key Indicators** (as approved)

1.2.1 The Project Development Objective (PDO) is the sustainable use and management of the GAS in Argentina, Brazil, Paraguay and Uruguay for current and future generations, supported by the joint development and implementation of an adequate, functioning aquifer management framework, based on sustainable technical, scientific, institutional, legal, financial, political, and environmental grounds.

1.2.2 In conformity with the GEF M&E guideline for IW, the PAD (p.3-4)) included key indicators under the three categories: Process, Stress Reduction and Environmental Status. The indicators and actual achievement are discussed under Section 3.2 (Achievement of GEO) below. In addition, four indicators --(a) *Pollution risks diminished or controlled:* (b) *Overdraft risks diminished or stabilized:* (c) *Risk of future inter-country groundwater conflicts diminished;* and (d) *Future mitigation and stabilization costs reduced*-- were identified to measure the Global objective and are also discussed in Section 3.2.

1.3 **Revised GEO (*as approved by original approving authority*) and Key Indicators, and reasons/justification**

1.3.1 The PDO was not revised.

1.4 **Main Beneficiaries** *(original and revised, briefly describe the "primary target group" identified in the PAD and as captured in the GEO, as well as any other individuals and organizations expected to benefit from the project)*

1.4.1 The targeted Project beneficiaries were the 92 million people living in the Guarani region. In addition, the beneficiaries include public and private institutions (mainly water agencies, authorities and water user organizations), Non-Governmental Organizations (NGOs), civil society organizations, universities, professionals in the field and policy makers at all levels. These individuals and entities will benefit from increased knowledge, better sharing of information and reduced conflict in relation to a strategic resource that potentially will provide: (i) a sustainable supply of safe water for human populations; (ii) high-quality water for industry; and (iii) a sustainable supply of thermal water for tourism, industrial and municipal uses.

1.5 **Original Components (***as approved***)**

1.5.1 As designed the Project had seven components:

1.5.2 ***Component 1. Expansion and Consolidation of the Current Scientific and Technical Knowledge Base on the Guarani Aquifer System (US$9.91 million or 37% of total Project cost):*** The aim of this component was to synthesize, analyze, and expand the knowledge base

2 During the Guarani Project preparation, the Bank was involved in the implementation and/or preparation of some 23 GEF IW Projects, in addition to 15 other, related GEF projects dealing with coastal and marine issues, and nine aquatic biodiversity projects with IW aspects. See the PAD for the Project. p. 19.

on the GAS and had two major sub-components: (i) Aquifer studies for consolidation and expansion of the scientific knowledge base; and (ii) Technical socio-economic assessments of current and future use scenarios of the GAS.

1.5.2. ***Component 2: Joint Development and Implementation of the Guarani Aquifer System Management Framework – (US$7.01 million or 26.2% of total Project cost).*** The aim of this component was to develop a framework for the coordinated management (technical, institutional, financial and legal) of the GAS and had five sub-components: (i) Design and implementation of an aquifer monitoring network; (ii) Development and integration of an Information System (SISAG - *Sistema de Informacion del Sistema Acuífero Guarani*); (iii) Formulation of a Strategic Action Program (SAP); (iv) Institutional strengthening; and (vi) formulation of Transboundary Diagnostic Analysis (TDA).

1.5.3. ***Component 3: Public and Stakeholder Participation, Education and Communication (US$1.31 million or 4.9% of total Project cost).*** The aim of this Component was to promote and support the participation and involvement of the public, and to foster environmental and water resources education, social communication, and the dissemination of knowledge. The component had four sub-components: (i) Design of a Regional Communications and Public Participation Plan; (ii) Establishment of GAS Citizens' Fund; (iii) Creation and dissemination of instruments to increase awareness, interest, and commitment among stakeholders; and (iv) Formulation of an Indigenous Peoples Strategy.

1.5.4. ***Component 4: Project Monitoring and Evaluation, and Dissemination of Project Results (US$0.48 million or 1.8% of total Project cost).*** The aim of this Component was to create and implement a system for recording and analyzing progress achieved during the Project implementation period. Two subcomponents were identified under this component: (i) Development and implementation of a monitoring, evaluation and feedback system; and (ii) Dissemination of Project results throughout the region and beyond.

1.5.5. ***Component 5: Development of Management and Mitigation Measures within Identified "Hot Spots" (US$3.73 million or 13.9% of total Project cost).*** The aim of this Component was to design, apply, and evaluate the costs and feasibility of good management practices at specific sites within the GAS region. Four areas for pilot subprojects were identified to test the proposed local management practices.

1.5. 6. ***Component 6: Assessment of Geothermal Energy Potential (US$0.28 million or 1.0% of total Project cost).*** The aim of this Component was to evaluate the geothermal potential of the GAS and was designed to be implemented in two phases. During Phase I, existing geohydrological data were planned to be compiled and evaluated. In Phase II it was planned to create a task force comprised of representatives from the four countries, supported by world experts in the study and use of the enthalpic energy and to conduct a scientific evaluation of the geothermal potential of the GAS based upon the data acquired during Phase one.

1.5.*7.* ***Component 7: Project Coordination and Management (US$ 4.04 million or 15.1% of total Project cost).*** The aim of this Component was to provide organizational and administrative support to the Project. The Project Secretariat (PS) was expected to carry out the traditional role of project implementation units and the National Coordinators (NC -- composed of representative from each country) was expected to act as a focal point for the dissemination of Project results, and coordination and communication with other GEF-IW projects within the Latin American region.

1.6 **Revised Components**

1.6.1 The components of the Project were not revised. However, during implementation, due to their close relationship, some studies were jointly contracted to achieve economies of scale.

1.7 **Other significant changes** *(in design, scope and scale, implementation arrangements and schedule, and funding allocations)*

1.7.1 In terms of Project design there were no major changes. The Project had a total of five amendments. The first amendment was part of Bank-wide action taken to change GEF Grants denominated in SDR to an equivalent in US$. The second amendment changed the Special Account to an Operational Account. The third Amendment changed the financing percentage following the Bank-wide revision of percentages of financing applicable to the four participating countries. The fourth Amendment extended the closing date from March 31, 2007 to January 31, 2009; made a reallocation to the Grant proceeds among categories and revised disbursement estimates. The fifth Amendment increased the authorized allocation to the Operational Account from US$600,000 to US$1.3 million.

2. Key Factors Affecting Implementation and Outcomes

2.1 **Project Preparation, Design and Quality at Entry**
(including whether lessons of earlier operations were taken into account, risks and their mitigations identified, and adequacy of participatory processes, as applicable)

2.1.1 Notwithstanding the lack of Bank operational experience in multi-country GW, good use was made of proven practices in aquifer management as well as GEF IW focal area experiences[3] in designing the Project. Based on lessons from GEF IW projects, the design correctly identified that "a significant lag time may occur between the preparation of the …SAP and its implementation. For this reason, the Project was designed as the first phase of a larger Program. Therefore, the elaboration of projects to implement the SAP will take place during the last year of the proposed Project.." (PAD, p.18). That was exactly what came to pass.

2.1.2 The design also identified an important set of risks and corresponding mitigation measures. One of the substantial risks that became relevant during implementation was "Project-supported research and analysis of the aquifer are not carried out in a timely manner, leading to delays in providing critical inputs to the SAP." Through the extension of the closing date this risk was addressed.

2.1.3 The Project was exemplary in its design of participation mechanisms that allowed for the involvement of learning institutions, NGOs, civil society organizations, public institutions at all levels and the public at large in all phases of the Project including consultation, implementation of Project activities and representation in local management. The evaluation report done as part of Project closing by the Organization of American States (OAS) indicated that in one of the workshops conducted during preparation more than 100 people participated representing a wide array of institutions of the four countries.

2.1.4 Although the Project design rightly identified the need for a proactive communication strategy, it did not identify it in the risk matrix. Early in Project implementation, the Project faced strong resistance from some groups who were providing somewhat distorted information to the public at large about the Project objective and its activities. However, given the wide consultation

3 Specifically, the PAD (p. 17) mentions the World Bank stakeholder consultation held during June 2000, and the GEF International Waters Conference held during October 2000 from which lessons were drawn.

during Project preparation conducted in the four countries, it was difficult to foresee the possibility of negative resistance to the Project.

2.1.5 Because of the lack of an existing institutional framework, Project design needed to put in place a complete framework including Steering Committee (SC), National Project Execution Units (NPEU) and the Project Secretariat (PS). This institutional framework and the mechanisms adopted proved to be highly successful and played a critical role in Project implementation. Details on the institutional framework and mechanisms are presented in Section 2.2 below.

2.1.6 The design, as represented in the PAD, was overly optimistic in terms of the time needed to implement a four-country project that covers a total area of 1.08 million Km.[2] [4] As a result disbursement estimates were also overly optimistic. An evaluation done by Independent Evaluation Group (IEG) in 2006, as part of Bank-wide review of regional projects, observed that "for the size of the Project area and the extensive list of studies planned under the Project, the number of Project staff planned in the PAD was unrealistic as it was found later during Project implementation."[5] In addition, from an operational perspective, the number of indicators was large, but deemed to be necessary in order to adequately monitor the different activities.

2.1.7 Overall, the design of the Project was sound and well articulated.

2.2 **Implementation** *(including any project changes/restructuring, mid-term review, Project at Risk status, and actions taken, as applicable)*

2.2.1 Project implementation was coordinated by the SC[6] at regional level, the NPEUs in each country, and local coordinating bodies (Pilot Local Management Commissions). The OAS was the executing agent and the PS, which played the role of project coordinating unit, was created under the administrative responsibility of the OAS. One representative from each NPEU formed the NCs group that worked closely with the PS in providing clearance to contract documents and reviewing advances in project execution. The NCs also served as a support body for the SC who informed their respective representatives on the advances and issues in project execution.

2.2.2 Initially, some time was needed to harmonize procedural differences between the OAS and the Bank especially in contract signing and procurement rules, among others.

2.2.3 Finding of the Mid-Term Review (MTR): The MTR:[7] (i) confirmed the relevance of the Project objective and that it should remain unchanged; (ii) proposed to extend the Project closing date and thus revise disbursement estimates; (iii) accepted the need to strengthen the PS by increasing staffing and expanding office facilities; and (iv) recommended to deepen the activities of the Project in the four pilot areas through contracting four local champions (facilitators).

2.3 **Monitoring and Evaluation (M&E) Design, Implementation and Utilization**

4 The project became effective 02/26/2003; original closing date 03/31/2007 (four years and a month)

5 IEG. 2006. "Guarani Aquifer Project: An Independent Evaluation of the World Bank's Support of Regional Programs." .

6 The Steering committee was formed by high level government officials from ministries of Environment, Water Resources and Foreign Affairs Relations from the four countries to provide overall policy level decision making.

7 See the Aide Memoire of the MTR mission conducted between February 14-25, 2006.

2.3.1 The PAD recognized the importance of M&E given the decentralized nature of Project activities. It also foresaw the establishment of an Operational Monitoring and Evaluation System (OM&E). An M&E team and system were put in place within the PS.

2.3.2 During implementation, the Logical Framework was updated following the Results Framework that introduced a temporal element into the M&E process. The updated Results Framework served Project supervision well at each stage of Project implementation – such as progress in the wells inventory, number of people accessing the web site, number of people reached through the awareness building activities, among others. Some progress needed to be measured in terms of percent of advance in implementation, as was done in the preparation of several maps supported under the Project. Periodic reports from the four pilot sites and from other Project activities, including the Citizen Fund and the University Fund, were fed into an M&E system managed by the PS. Also, the NPEU reports were consolidated and provided in Project progress reports prepared by the PS for SC Project oversight. The Oracle based system of the OAS facilitated the monitoring of financial utilization and commitments and performed satisfactorily for Project supervision and planning.

2.3.3 During several stages of implementation, the Project conducted evaluations that were important in adjusting and establishing sequences and timing of Project activities. These evaluations were carried out in conjunction with the MTR and with preparation of the TDA and the SAP. In addition, the OAS contracted an external consultant to do the final evaluation of the Project. Throughout Project implementation, the Project benefited from peer reviews, feedback and quality control from the countries that was put in place by the OAS/PS. A total of 40 quality control interventions were conducted. In addition to the usual Bank supervision, GWMATE[8] provided important Technical Assistance (TA) by evaluating different products of consultants hired by the Project. GWMATE also provided close oversight and support to the pilot subprojects. All these interventions supported in the monitoring of Project implementation progress, ensuring the quality of the outputs, and assessing that the Project remained relevant and on track. The different stakeholder consultations also contributed to monitoring public attitudes about the GAS and the Project.

2.3.4 As a final product, the Project deployed the GAS Information System (SISAG), with each country having access to the system and an interface to directly update data (See Annex 2, Component 2). Through SISAG the GAS now has a state-of-the-art information system that will be instrumental in future monitoring and management of the aquifer.

2.4 **Safeguard and Fiduciary Compliance** *(focusing on issues and their resolution, as applicable)*

2.4.1 The PAD identified three safeguards issues that apply to the Project – environmental assessment (OP 4.01), indigenous people (OP 4.10) and international waters (OP 7.50).

2.4.2 The Project[9] clearly contributed to significant improvements in environmental management by: (i) greatly improving the knowledge base; (ii) developing and adopting manuals for well drilling and protection, (iii) developing groundwater models that will aide decision-making for sustainable management and use of the aquifer; (iv) defining criteria in the pilot areas for land use and solid waste management to protect the aquifer from contamination; (v) providing information and guidance for locating and protecting wells in the pilot areas where they will reduce overexploitation and reduce the risk of contamination; and (vi) establishing the extent of

8 The Groundwater Management Team (GWMATE) is a group of international experts that provides Bank teams and client countries with technical assistance in groundwater management, and is supported by the Netherlands and British governments.

9 For environmental assessment purpose, the project was classified as Category B.

sustainable geothermal water use that included: (a) identifying alternative use of geothermal water, (b) formulating and adopting guidelines to control the potential for overexploitation; (c) sensitizing the local users and authorities on the need for recycling water after geothermal use; (d) playing a catalytic role in the establishment of common standards between neighboring transboundary localities; and (f) defining the minimum distance required between wells. (Annex 2 provides detail on manuals and potential uses).

2.4.3 At the initial stage of Project implementation, as designed, the PS informed indigenous people's organizations in the three countries (except Uruguay where no indigenous peoples were identified during Project preparation) about the Project and progress in its implementation. Later, the Project developed an Indigenous People's Strategy that was disseminated widely. Beyond what was seen in the PAD, the Project specifically earmarked resources from the Citizen Fund to ensure the participation of indigenous organizations in awareness building – two subprojects funded by the Citizens Fund focused on indigenous people issues. As a result of the development of this strategy, the SAP was able to identify and incorporate actions that the three countries should follow to benefit and ensure the participation of indigenous people in the future use and management of the Guarani aquifer.

2.4.4 For projects on international waterways, the requirement of (OP7.50) of the Bank is for the riparian states to be formally notified in regard to the proposed Project. However, since the four riparian countries were represented on the SC and jointly defined Project activities as part of approval of annual plans, separate notification was deemed unnecessary.

2.4.5 **Fiduciary Compliance:** The Project complied with fiduciary requirements, as the quarterly Financial Management Reports (FMR) and audit reports were in full compliance with Bank procedures. The annual Project audit was carried out within the overall annual audit of the OAS. This approach to auditing was pioneered by the Guarani Project and was later adopted by another GEF financed and Bank implemented project[10]. No major problems surfaced with regard to fiduciary compliance. Each year procurement post-reviews were conducted by the Bank and no major problems were found in these reviews. However, it should be noted that sometimes the submissions of quarterly FMR were delayed beyond the agreed dates set out in the Grant Agreement.

2.5 **Post-completion Operation/Next Phase** *(including transition arrangement to post-completion operation of investments financed by present operation, Operation & Maintenance arrangements, sustaining reforms and institutional capacity, and next phase/follow-up operation, if applicable)*

2.5.1 The Project was designed as the first stage of a long-term programmatic intervention in the management of the GAS. At the end of Project implementation, the four countries decided that the institutional mechanisms (SC, NPEU, PS and local entities) established during Project preparation and enhanced during implementation will continue to operate in the future. The management of the GAS will be the responsibility of the line agencies in each country especially at local level.

2.5.2 As part of the SAP, the countries, *inter alia*, agreed to: (i) maintain the SC that will conduct at least three regular meetings annually – as compared to two annual meetings during Project implementation; (ii) reorganize the PS office that will be located in Montevideo (Uruguay) to facilitate coordination among the countries; (iii) assume specific responsibility for monitoring and coordinating follow-up activities; and (iv) finance follow-up activities from their own

10 Building the Inter-American Biodiversity Information Network (IABIN) project.

budgetary resources. In addition, the countries are seeking to set up future institutional arrangements that will integrate GW and surface water management in the Rio La Plata Basin and the Guarani aquifer region.

2.5.3 All of these arrangements bode very well for the sustainability and further development of Project outcomes.

3. Assessment of Outcomes

3.1 **Relevance of Objectives, Design and Implementation** *(to current country and global priorities, and Bank assistance strategy)*

3.1.1 The long-term objective of the Guarani Project, to sustainably use and manage the GAS is still very relevant for the four countries. IEG (2006) made the following observation on the relevance of the Project:

> The Guarani Aquifer Project is very relevant to the issues of integrated water resource management in the region… The Guarani Aquifer Project itself appears to have strong official support from the four participating countries, as well as from a number (but not all) civil society organizations. In mid-January 2006, the National Water Resources Council of Brazil approved a "National Integrated Water Resources Management Plan," which includes a chapter on groundwater for the first time. [I.E.G. 2006: p. 6]

3.1.2 The recently modified or adopted different water regulations, decrees and laws of each country recognized the importance that the countries have now attached to GW management and its sustainable use.

3.1.3 **Design relevance:** The Project genesis is found in the different universities of the region who postulated that the Guarani aquifer was a huge regional GW system shared among the four countries. However, detailed and comprehensive knowledge covering the whole system was not readily available. Therefore, the Project was designed to focus on improving the knowledge base that was to be followed by preparation of a SAP that would define future institutional coordination mechanism among the four countries. Thus, the main design of the Project was and still is highly relevant.

3.1.4 The Project is in line with the GEF IW focal area that addresses, among other things, to help "countries to collaborate with their neighbors to modify human activities that place stress on transboundary water systems…"[11] In conformity with GEF IW focal area, this Project supported the countries in learning to work together on their key transboundary concerns and set priorities for joint action as reflected in the SAP and other auxiliary declarations. As a result of the Project, the risk of over-extraction and contamination of GW resources and any transboundary impacts have been significantly reduced.

3.1.5 The Project was a pioneer, not only because it was designed as a preventive intervention to specifically support the future management of GW but also because it was the first multi-country GW management undertaking for the GEF together with the Bank. The relevance of the Project can be found in its priority in the four countries and from the current CASs. The CAS for Argentina[12] specifically stated that regional GEF activities are focusing, among others,

11 See http://www.thegef.org/interior_right.aspx?id=236.

12 The World Bank. 2006. Argentina Country Assistance Strategy. May 4, 2006. Report No. 34015-AR. However, the CPS (Report # 48476-AR and dated March 31, 2009,) that became operational after the Project closed does not refer to GAS.

on shared water (both surface and the Guarani aquifer). The Brazil: Country Partnership Strategy (CPS[13] FY2008-2011) states that the Bank Group will assist Brazil in fostering coordinated efforts to address large transboundary issues in partnership with, among others, the Guarani aquifer riparian countries. Although the CASs and CPS for Paraguay[14] and Uruguay [15] did not specifically mention the Guarani aquifer, both CASs and the CPS aimed to improve water resource management and enhance coverage of water supply and sanitation services.

3.16 Some of the factors that collectively make the Guarani aquifer a strategic resource for the four countries in the future include: (i) climate change and its impact on the water resource balance; (ii) intensification of agriculture and the resulting increase in demand for water; (iii) expanding urbanization that intensifies the demand for reliable water supply, (iv) recurrent droughts; (v) increased pollution of surface water; (vi) the aim to improve access to potable water in the rural areas; and (vii) the reliance now and in the future of many settled areas on the Guarani aquifer for their water supply for municipal and industrial uses. Thus, assessed from the perspective of the four countries water development agenda, CASs, and the future strategic importance of the GAS, the objective of the Project is still highly relevant.

3.2 **Achievement of Global Environmental Objectives** *(including brief discussion of causal linkages between outputs and outcomes, with details on outputs in Annex 2)*

3.2.1 In evaluating the overall objective of the Project, the basic underlying assumptions of the Project design have to be considered. First, according to the PAD (p.56), the Project was conceived and designed as: "a first step toward achieving the long-term objective of a sustainable management and use of the [GAS]." Second, the Project was conceptualized as a protective and preventive intervention to reduce future risks of pollution, overdraft, intra-country conflicts, and high cost of future mitigation and stabilization measures. Third, the Project was conceived to usher in a cooperative framework that would lay the groundwork for the long-term objective of the sustainable and integrated management and use of the GAS. Reviews of the Global PDO indicators show that the aim of the Project was to reduce risks but not necessarily to reverse degradation since in general the aquifer was assumed to have limited contamination and little utilization relative to its potential. In light of this main conclusion addressing the potential risks before the onset of resource degradation was the right approach made during Project preparation.

3.2.2 Although the PDO might appear to be a long-term higher level objective, it provided a unique opportunity to put in place an adequate, functioning aquifer management framework, based on sustainable technical, scientific, institutional, legal, financial, political, and environmental grounds in order to ensure sustainable use and management of the GAS for current and future generations. The PDO was therefore determined to be highly relevant and achievable.

3.2.3 ***Establishment of an adequate, functioning aquifer management framework:*** One of the Project main outcomes is the establishment of the institutional mechanism to coordinate the activities of the four countries in the management of GAS that did not exist before the Project. The Project also extended this new culture of cooperation among specialists, universities and institutions in the four countries. Given results of the technical and scientific studies (see para. 3.23 below), the adopted coordination mechanisms are very light. The responsibilities of light

13 The World Bank. 2008. Country Partnership Strategy. Report No. 42677-BR.

14 The World Bank. 2003. Paraguay: Country Assistance Strategy. November 2003. Report # 27341-PA. The CPS (Report # 48087-PY) was approved after the Project closed (April 2009)

15 The World Bank. 2005. Uruguay: Country Assistance Strategy. May 2005. Report # 31804-UY.

coordination mechanisms of the future PS include: (i) reviewing policy and developing proposals; (ii) providing for comprehensive monitoring; (iii) coordinating institutional capacity improvements and provision of TA; (iv) developing and improving manuals, procedures and guidelines; and (v) continuously updating the knowledge base.

3.2.4 ***Development of the technical and scientific basis:*** Studies conducted through the Project concluded that lateral movement of GW in the GAS is very slow and impacts from over pumping and pollution are highly localized. This conclusion determines the type of coordination (including political, legal, institutional and financial) that is needed because the actions of one country will have no impact on the resource in other countries except in very localized areas. Sharing of information and management approaches is beneficial and coordinated management is specifically needed in a few small localities where transboundary effects are perceived. Even though the need for coordinated management is limited to a few local areas, the Project significantly enhanced the capacities of the four countries to manage the GAS and their ability to have a rational dialogue. In fact, one of the important outcomes of the Project was this understanding: that management of the aquifer is essentially a local set of activities. During Project preparation the general opinion of governments, institutions and civil society was that joint coordinated management was needed for the entire aquifer. The four countries now have a good understanding and feel much more confident to develop and manage the aquifer individually without worrying about wide-ranging regional/transboundary impacts. This is a huge benefit. It would have been very difficult to get to this point and to have this shared understanding without having a regional project. There was insufficient information and knowledge basis (aquifer extent, geology, hydrogeology, hydrogeochemistry, flow dynamics, age of water, etc.) prior to the Project to be able to reach this understanding and conclusion.

3.2.5 Another important outcome of the project is the extensive knowledge and the related technical approaches and methodologies created that were precursor for the management of GAS and its sustainable use. Continued cooperation will allow for continuously improving this understanding, approaches, methodologies, and sharing of data and information in the future.

3.2.6 The Project achievement could be assessed from the perspective of GEO key performance indicators and GEF IW indicators. As a preventive project, the key performance indicators basically targeted the reduction of future risks. The four global objective indicators and their status is given below: (details are given under Component 2).

(a) ***Pollution risks diminished or controlled:*** Almost 90% of the resource is covered by thick basalt (confined aquifer) and therefore to a large extent the aquifer has little exposure to pollution. However, in specific localities where the sandstone formation outcrops, the potential risk for pollution is higher (such as the pilot regions Rivera/Santana and Ribeirao Preto). For these areas the Project put in place a management framework and specific actions. The approaches adopted for these areas and the fact that the resource is not treated as an open resource throughout most of its extent have resulted in diminishing the pollution risks.

(b) ***Overdraft risks diminished or stabilized:*** The GAS does not show signs of overdraft except in very localized areas. It is estimated that the total annual volumes of recharge and discharge are basically in balance. The annual water extraction stands at about 1.04 billion m^3/y, which is about 0.003% of the estimated 30 trillion m^3 stored in the aquifer. Nevertheless, there are some specific areas that exhibit some existing and a risk of potential future overdraft. One of these areas is Ribeirao Preto in Brazil (one of the pilot areas) where detailed studies were conducted and relevant measures to reduce the risk were introduced. This risk, where it occurs has been addressed by putting in place, well spacing standards, and zoning for protection

and extraction. In general, overdraft risks are now minimal due to the management framework established.

(c) ***Risk of future inter-country groundwater conflicts diminished:*** Such risk was framed based on an early conceptualization that the use of GW from the GAS in one country could be at the expense of the other riparian countries. This concept was derived from the characteristic feature of surface water that exhibits upstream-downstream dynamics in a river basin. However, the knowledge generated through several studies dispelled this misconception in that the lateral flow of water is extremely slow, and is driven by natural hydraulic gradients that are only modified in local areas where human interventions (extractions and artificial recharge) are significant. For local transboundary areas with the potential risk of conflict, the Project developed specific actions and cooperative management frameworks that have successfully addressed this risk since the countries (and municipalities) are working closely together.

(d) ***Future mitigation and stabilization costs reduced***: The basic fact that this Project was preventive in nature ensures that it will be more cost effective than the alternatives. Remediation of water quality deterioration in GW bodies, if at all possible, is a very expensive undertaking. Recuperation of GW levels in overexploited areas requires drastic measures that are very difficult to implement. The application of improved methodologies and management approaches developed under the Project, including monitoring, will ensure that there are timely interventions if and when the resource shows signs of stress.

3.2.7 Streams, lakes, wetlands and the biodiversity covering land areas to a large extent depend on the sustainable discharge of GW for a healthy and flourishing ecosystem. Thus, by ushering in the sustainable management that meets the demand for human use, and also meets environmental needs, the Project will make a significant long-term contribution to the GEF Environmental Objective.

3.2.8 Among the relevant process indicators[16] included in the PAD, the Project achievement includes:

(a) Establishment of an institutional framework: The countries, through the SC (at multi-country level), the NPEUs (one per country), and the Regional Coordination Unit, has established the institutional framework.

(b) Existence of SAP: The SAP was finalized and approved by the SC. The SAP has now become a living document to lead the joint and individual actions of the countries

3.2.9 In Stress Reduction,

(a) Communications campaign: An intensive communication campaign was undertaken that reached more than 2.5 million people. The GAS is now well known not only within the four countries but in international circles as well.

(b) Water quality threats identified and quantified: Potential water quality threats were identified through the preparation of a vulnerability map and analyses that identified lack of adequate wastewater and solid waste management, intensification of agriculture and unsupervised well drilling (well head contamination). However, an important finding of the Project is that in its present state, the Guarani aquifer water quality is essentially without contamination from human activities. Except for the finding that showed somewhat elevated

16 The GEF International Waters categorizes relevant indicators into 3 major categories: Process, Stress Reduction, and Environmental Status indicators.

concentrations of nitrates or other chemicals in some wells (still within acceptable limits) and areas with high natural salinity or arsenic, the general conclusion was that the Guarani aquifer has very good water quality through most of its extent and almost no contamination.

(c) Existence of norms for well design, construction and maintenance: Well design, construction and maintenance guidelines were developed and adopted for different uses of GW (domestic and industrial water supply, geothermal) and taking into account the specific zones of the aquifer (outcropping, transition and confined).

(d) GW overuse identified together with management measures implemented and monitored in specific "hot spots": In the Ribeirao Preto pilot area, there is presently some overexploitation and a risk of a worsening overexploitation problem was identified. Management measures were identified and adopted.

(e) In the Concordia-Salto area, studies indicated that there is a potential for overexploiting geothermal water resources and measures were designed for limiting GW competitive extraction through well spacing and other relevant measures for new geothermal development.

3.2.10 In terms of Environmental Status indicators, the following tasks were accomplished:

(a) The western limit of the aquifer was not clearly understood prior to the Project. Based on geological criteria, it is now has been better defined. As a result the aquifer area in Argentina was revised from an earlier estimate of 225,500 km^2 to 228.255.26 km^2.

(b) Conceptual and mathematical models that capture the hydrodynamic behavior and allow for the evaluation of different development, management and climate change scenarios were developed and are excellent tools for future management of the aquifer.

(c) The quantity of water extracted annually from Guarani is estimated at 1.04 billion m^3/year.

3.3 **Efficiency** *(Net Present Value/Economic Rate of Return, cost effectiveness, e.g., unit rate norms, least cost, and comparisons; and Financial Rate of Return)*

3.3.1 Estimates of investment efficiency using NPV or ERR were not made for the Project. However, for the pilot areas a study[17] conducted by the Project indicated that Guarani groundwater is an economically efficient mechanism to provide dependable public water supply. The analysis showed that: (i) for Ribeirao Preto the IRR was 29.8%, with a long-term average marginal cost of US$0.68/$m^3$, which compares favorably with US$0.88/$m^3$ for Montevideo, Uruguay; (ii) for Itapua, the IRR was 12.99% with an average marginal cost of US$0.84/$m^3$; and (iii) Rivera/Santana, 30.1% with a marginal cost of US$0.86/$m^3$.[18]

3.3.2 One important factor that could also serve as a proxy for the efficiency of the Project is related to the basic tenet on which the overall design of the Project was based, i.e., prevention is the

17 See report of the project: "Evaluación del Potencial de Usos Termales y No Termales del Agua del SAG". Consorcio Guaraní. Montevideo. Enero, 2008.

18 The marginal cost is relatively high, which could be explained by the huge surge of energy cost during this study period. However, several studies have shown that energy utilization for pumping GW to be less than alternative means of water service delivery (recycling, desalinization & surface water purification).

most cost effective intervention in GW. In general, it is nearly impossible and very costly to restore a contaminated groundwater resource. It is also very difficult and costly to recover water levels to historical norms in overexploited areas.

3.3.3 The majority of the people who lack access to a reliable and safe water supply system reside in the rural areas of the four countries. [19] In areas where GW is available, it is generally the most efficient and cost effective method of improving coverage of access to water supply since scattered settlement patterns (the characteristic feature of rural areas) would require huge investment cost for building water delivery networks and infrastructures. Improving qualitatively the understanding on the dynamics of the GAS and the improved management mechanisms ushered in by the Project will contribute to the efficient and reliable provision of water supply to areas within the aquifer region.

3.4 **Justification of Overall Outcome Rating** *(combining relevance, achievement of GEOs, and efficiency)*
Rating: Satisfactory.

3.4.1 The relevance of the Project is very clearly established given the action taken by the countries to include GW in their overall water resource agenda and collaboration mechanisms they established. The relevance is particularly important in the pilot areas. By identifying actions that the countries should implement, the Project introduced a new pattern of utilization, management and cooperation. In addition, the Project created the institutional framework and mechanisms for future management of the resource at all levels that the countries have agreed to continue to finance.

3.4.2 Assessed both from PDO and IW indicators, as discussed above in detail, the Project has successfully achieved its goal. The Project supported the four countries in the joint development and implementation of an adequate, functioning aquifer management framework. The fact that: (i) the four countries will continue to cooperate and coordinate their activities through the SC (for policy, decision making and budgetary aspects) and the PS – for technical matters; (ii) there are a set of detailed studies covering relevant thematic areas, a shared vision, and a continuously updated information system; (iii) an organizational set-up has been agreed for continuing with the activities initiated in the pilot localities; (iv) participation of the stakeholders at local, state/provincial, and national levels in GAS management is now functional and governments are committed to the participatory mechanism; and (v) the countries have committed their own budgetary resources; all demonstrate that the countries know and have agreed on what is necessary for the management of the GAS. This framework will also improve the management of other GW systems in the countries and will contribute towards improving integrated water resources management.

3.5 **Overarching Themes, Other Outcomes and Impacts** *(if any, where not previously covered or to amplify discussion above)*

(a) Poverty Impacts, Gender Aspects, and Social Development

3.5.1 The Project was not a poverty-focused intervention and did not specifically target a gender theme. However, as part of Citizens' Fund some subprojects did address gender as it relates to GW issues, which was limited to awareness building among female-headed households. The Project has contributed to social development through its direct involvement of NGOs,

19 For example, in Brazil "lack of access to improved water supply is mainly a rural issue, with two-thirds of the 34 million people without services living in rural areas." See CPS, 2008, Annex p.20.

universities and civil society organizations and through its development of the Indigenous Peoples Strategy. This Strategy identified that raising the awareness of these communities on the importance of clean water was found to be highly relevant. The Project supported putting in place a knowledge base, monitoring system and protection measures that will ensure the availability of good quality uncontaminated water for human consumption in the future, which is potentially a big benefit for the poor.

3.5.2 Further, the impact of the Guarani Project is beyond the Guarani aquifer proper. The methodologies developed in studying aquifers, the instructive experiences in establishing management frameworks, and the manuals and guidelines produced through the Project, among others, are results that other aquifers in the four countries will benefit from. The fact that GW has now become an integral part of the water agenda in the four countries attests to the fact that the impact of Guarani Project was beyond GAS proper. By identifying arsenic and saline areas, the Project has contributed to the health of the population of the region living in these specific areas. In addition, the Project has created huge interest in the GAS and there are now a number of PhD and MSc students studying the aquifer, as well as a number of environmental NGOs working on issues related to Guarani. The interest the Project managed to galvanize was an additional relevant outcome of the Project.

(b) Institutional Change/Strengthening
(particularly with reference to impacts on longer-term capacity and institutional development)

3.5.3 This Project had a substantial institutional impact and institutional development and strengthening is an important part of Project outcomes. In fact, one of the major impacts of the Project has been to establish an institutional framework from the local to the regional level that did not exist before the Project. The improved knowledge base on the Guarani aquifer and the enhanced technical capacity of specialists and decision makers provides a good foundation for improved management of the aquifer in the future. The Project involved a wide array of organizations through its participatory mechanisms and raised their understanding and awareness in GW management. Undeniably, the Project has ushered in a behavioral change in users and policymakers on the need for protection and management of the Guarani aquifer, which, before the Project, was treated as an open resource available for use with only minimal consideration or understanding of the resource dynamics and vulnerability.

3.5.4 Groundwater management has entered into the activities and agendas of agencies whose responsibilities include monitoring, regulating, administering, using or managing of water resources. At the regional level, the continuation of the SC, and at the country level, the creation of new entities or the strengthening of existing water agencies demonstrate the achievements in institutional development. The project also supported the creation of technical committees in: SISAG; Monitoring and modeling; Capacity building and diffusion; and Local management promotion group composed of specialists in the field from the four countries.

3.5.5 The Project also contributed to improving the capacity of universities. Through a BNWPP[20] grant, the Project set up a University Fund that supported nine subprojects out of a total of 29 proposals presented for funding. A total of 21 universities and four public research institutions from the four countries were associated to conduct the nine studies. The combined results of the activities financed by this Grant included: (i) the training of high level professionals (14 in PhD and MSc and 16 in BSc), (ii) the support for the development of five courses in groundwater; (iii) high level scientific and technical analysis on the Guarani aquifer through

20 The Bank-Netherlands Water Partnership Program – BNWPP.

nine studies; (iv) mainstreaming of groundwater issues into the academic agenda of the universities in the GAS region; and (v) introduction of a state-of-the-art system of monitoring the Guarani groundwater, such as the use of satellite remote sensing data.

3.5.6 The Project utilized several mechanisms to improve the capacity of the professionals involved in groundwater in the four countries, including more than 20 technical workshops. Through a twinning and internship program, 40 professionals were trained by working with the consultant firms contracted to study the Guarani aquifer and by studying specific themes related to the GAS. In collaboration with the US Geological Survey, professionals responsible for groundwater management from each country participated in a study tour to learn from US and Mexico experience in transboundary groundwater management.

3.5.7 The Project supported the production of several guidelines and manuals that will be the basis for providing permits for well drilling and development, for monitoring and for regulating the use of GAS water. Today, local municipalities, state/provincial governments, and national water agencies all share the same state-of-the-art database with a reliable data set that was made possible through the Project.

3.5.8 As a part of the awareness building, the need to better understand the Guarani aquifer has entered into the education programs of primary and secondary schools in the region although not into the curriculum. School children are now being sensitized about the resource and the need for protection of the aquifer. Educational materials were part of the outputs of the activities financed under the Citizens' Fund. German Geological Survey (*Bundesanstaltfuer Geowissenschaften und Rohstoffe-- BGR),* in Paraguay, also developed excellent educational materials on the GAS that will continue to enhance awareness building activities started by the Project.

3.5.9 The institutional strengthening has also benefited NGOs, civil society organizations and indigenous communities by improving their knowledge about the Guarani aquifer and through the provision of information and guidelines developed through the Project. These organizations now have a much better understanding of the significance of the GAS and as a result can better contribute to improved management of the aquifer. For example one NGO (Raykatu) in the Rivera/Santana pilot area has taken inventory of unlicensed private shallow wells, independent of the Project, with the aim to support the effort in protecting the aquifer from pollution-related contamination. Another organization has developed an innovative simple physical model to demonstrate how the GAS operates.

3.5.10 At each country level, significant advances have been made in institutional development relative to groundwater management, in general and Guarani aquifer management, in particular.

(a) In Argentina, local actors, provincial and national responsible agencies in GW management have developed a permanent working relationship coordinated by the new Directorate for GW in the Sub-Secretariat for Water Resources (*Subsecretaría de Recursos Hídricos*) that was created as an outcome of the Guarani Project. As a specific outcome of Project preparation, the National Government created the Inter-ministerial Committee for GW, to help improve integrated water resources management. In addition, provincial governments have placed GW management prominently on their water management agenda.

(b) In Brazil, management of the GAS was included within the Implementation of Integrated Management of Surface and GW Program for 2008-2011 with a budgetary allocation of $18 million. State governments have included GW in their water agendas and have invested in

studies, monitoring and in general improving the institutional basis necessary for sustainable management.

(c) In Paraguay, the Project was prepared when the country lacked a well-defined framework for GW management. With active participation and support by the BGR, the understanding about the need for the management of the Guarani aquifer was quickly enhanced. The awareness and the interest created provided stimulus for the passage of the Water Law by the Paraguay Parliament in 2007. As a further outcome of the Project, the Government created a Guarani Aquifer Unit within the Ministry of Environment.

(d) In Uruguay, although there was a semblance of initial management framework during Project preparation, the Project strengthened the existing low level awareness of the public on the socio-economic and strategic importance of the Guarani aquifer. A law which is under consideration by parliament includes the creation of Guarani Aquifer Management Unit to ensure participation and the sustainable use of the aquifer.

(c) Other Unintended Outcomes and Impacts (*positive or negative, if any***)**

3.5.11 At the outset, the Project faced a significant amount of negative resistance from some NGO groups, mainly in Argentina and Brazil, that characterized the Project objective as a North American (government and/or international corporation) intervention to control the GAS and privatize its use. However, through the Project's awareness and communication campaigns and the active leadership of the SC, in the end, it was clearly understood that the aquifer and the Project were owned by the four countries, which ensured that the Project was carried out in order to benefit the region.

3.5.12 As an upshot of the initial negative campaign, major media interest was generated in the region. The aquifer and the Project continuously garnered attention from the local, national, regional and international media. This media attention provided a means for the four countries and the PS to correct misconceptions and generate significant support for Guarani aquifer protection and for the Project.

3.5.13 Throughout the GAS region there has been a significant increase in land prices, which is partially ascribed to an increased understanding that there is a vast potable water resource available in the area.

3.6 **Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops** *(optional for Core ICR, required for ILI, details in annexes)*

3.6.1 Not applicable.

4. Assessment of Risk to Development Outcome
Rating: Satisfactory

4.1 The Project objective enjoys a wide spectrum of support at regional, national and local government (state, provincial and municipal) levels. Such support emanates from the realization that the Guarani aquifer is an important strategic resource as a source of water for different uses. The support of the governments is clearly demonstrated, *inter alia*, through the institutionalization of GW management undertaken by all the countries and the allocation of budgetary resources for the Project and for follow-up activities.

4.2 The conclusion that the risk to the development outcome is low is justified by the institutional framework established at different levels; the improved professional capacity; the interest created in studying further the aquifer through universities; the different agreements reached among the countries; the manuals and methodologies developed by the Project; the technical knowledge base created; and the legal framework established by each country. .

4.3 As mentioned above the management of the Guarani aquifer is best carried out at the local level. A critical-mass of awareness, especially within NGOs and other civil society organizations has been created in each country that provides the foundation for further advances. In some countries, e.g. Brazil, there are strong groundwater associations that will ensure that GW issues and their management remain visible on the overall water agenda. The fact that the Project survived a negative campaign and won support at all levels bodes well for the future sustainability of Project outcomes.

4.4 However, there are three factors that could potentially pose a risk to the development outcome.

(a) *The fact that in general there are no potential upstream-downstream impacts and that GAS management is essentially a local issue may reduce the incentive for cooperation among the countries*. However, this risk is considered to be low given that the level of interest and enthusiasm of the countries and the fact that they have maintained and agreed to strengthen their cooperation in coordinating their activities in the management of the GAS.

(b) *The negative campaign about international intervention could reemerge.* The fact that the institutional framework put in place and the agreed SAP is now managed by the countries without the involvement of international organizations makes this risk negligible.

(c) *The fact that there is very little present danger of significant overexploitation or contamination may lessen the priority given to the aquifer's management.* The mainstreaming of GW management into existing institutional mandates, the major awareness building that the Project successfully implemented, the existence of interest groups, the commitment of the countries to collaborate in monitoring and coordinating their activities and in general the behavioral change this Project has ushered in significantly lessen the risk that management and conservation of the GAS will disappear from the agenda of the water sector of these countries. Through the Project a general understanding was reached about the importance putting in place and carrying out preventative measures.

5. Assessment of Bank and Borrower Performance *(relating to design, implementation and outcome issues)*

5.1 **Bank**

(a) **Bank Performance in Ensuring Quality at Entry** *(i.e., performance through lending phase)*
Rating: Satisfactory.

5.1.1 Although the Guarani Project was the first international groundwater project, supported by the Bank through GEF, the Bank team was able to guide Project preparation towards a well-thought out and balanced design. The Bank team was proactive in: (i) making use of available knowledge; (ii) enabling the creation of forums for participation of the stakeholders; (iii) identifying and focusing on different relevant management themes; (iv) strongly supporting the setting up of an institutional framework and mechanisms for good Project implementation; and (v) identifying representative pilot regions with a broad array of problems (the four pilots represented and emphasized overexploitation -- Ribeirao Preto; possible contamination and pollution -- Rivera-Santana; geothermal potential -- Concordia-Salto; and

potential agricultural non-point source contamination -- Itapua). As noted by the IEG[21] evaluation, stakeholders praised the substantial technical background of the first Bank Task Team Leader (TTL) who took an active role in Project preparation and oversaw the first two years of implementation.

5.1.2 Recognizing that coordinating such a complex and wide-ranging multi-country groundwater project would require significant diplomatic and coordination skills and recognizing that the Bank structure and potential for oversight and supervision could be insufficient, the Project preparation team and the four countries were right to select the OAS as executing agency -- an institution that has accumulated experience in the Region in managing international water projects.

(b) Quality of Supervision (including of fiduciary and safeguards policies)
Rating: Satisfactory.

5.1.3 Overall, the Bank was able to deploy high level staff in the management of the Project throughout the project cycle. All TTLs (there were three) maintained effective working relationships with the GEF, the OAS, and with other partners. In addition, the Bank brought high level advisory and TA through GWMATE. As expressed by IEG: "Stakeholders give Bank staff high marks for its technical expertise during Project preparation and implementation."[22] While the review of procurement documents by the four countries was going on, the Bank team reviewed the documents in parallel thereby reducing the approval period after the countries provided their clearance. The Bank team also proactively supported the OAS in harmonizing the two institutions' procedures in procurement, financial management reporting and other operational issues.

5..1.4 The Bank facilitated information exchange among the donors and partners (Bank/GEF, BGR, International Atomic Energy Agency – IAEA, and OAS) that was instrumental in optimizing the use of resources in data collection and in generation of high quality Project outputs. The Bank team also emphasized the necessity for very close coordination among the different consultants contracted to conduct technical studies, and supported the prioritization and sequencing of activities thereby helping to ensure that the output of one activity could serve as an input to another. The Bank team was also able to provide very important advice as information started to be generated. The counterpart Project team could have easily gone off track given the volume of information that they were receiving. The Bank team was instrumental in distilling what was relevant and ensuring that the Project kept its priorities right.

5.1.5 The Bank proactively worked to find solutions when the Project was faced with a negative campaign. High-level Bank communications staff worked with the countries to develop a communication plan, which was later successfully implemented and served to increase awareness and reduce concerns. In addition, the Bank, through its LCR Communication Advisor, provided information on the Project's objective and activities to environmental journalists that contributed to an observed shift in public perceptions towards a more positive response to the Project. The Bank team coordinated and directly contributed to dissemination of information about the Project, which included presenting the Project at international seminars as well as to Executive Directors and ambassadors of the four countries.

21 IEG. 2006. ibid.

22 IEG. 2006. ibid. p. x.

5.1.6 The Bank's support for increasing the capacity of the PS and in improving the procedures that governed the way the PS carried out its functions was very instrumental in improving the pace of Project implementation. Bank supervision was also innovative in suggesting that the Project should have a presence at the local (pilot area) level which resulted in the contracting of four facilitators for each one of the pilot areas. IEG made the point that the establishment of: "a project institutional presence at the pilot site level has been a widely recognized innovation."[23] The supervision team also supported the development of Local Action Plans to guide activities at the pilot level and shape the work of local institutional set-ups.

(c) Justification of Rating for Overall Bank Performance
Rating: Satisfactory.

5.1.7 Overall the Bank's performance was satisfactory. The Bank team: (i) guided the excellent preparation of a highly complex (both technically and institutionally) project; (ii) provided strong support and made timely decisions as Project implementation was faced with a variety of problems; (iii) provided high-level technical assistance; (iv) collaborated with partners; (v) worked closely with the SC; and (vi) supported and arranged the participation of high level professionals in international workshops and working visits to ensure that they benefited from top quality TA.

5.2 **Borrower**

(a) Government Performance
Rating: Highly Satisfactory.

5.2.1 The four country governments were represented through the SC. In the face of the negative campaign against the Project, the SC remained focused and did not waver from its support for the Project. This was a big achievement given the political nature of the negative campaign and the possible mistrust that could have emerged. During the Project implementation period, Argentina and Uruguay were engaged in a highly charged disagreement on the environmental impact of a paper mill being built on the Uruguay side of the border of the two countries. The fact that the SC functioned as a solid group (while two of the countries that are parties to the SC were engaged in hot debate) testifies to the commitment that the four country governments afforded to this Project.

5.2.2 The SC was very active and strongly took ownership of the Project on behalf of the four countries. The SC had the responsibility of approving annual plans, facilitating counterpart contributions by each country and overseeing the technical direction as reported to it by the National Coordinators (NCs). The SC successfully executed its responsibilities and promoted the participation of all donors (BGR, IAEA and the Bank) in its regular semi-annual meetings. In addition to semi-annual meetings, the SC conducted extraordinary meetings as was necessary to discuss pending issues or approve Project documents. The SC members were actively engaged throughout Project implementation demonstrated by their detailed review and comments on Project documents and their review and approval of Project annual plans.

5.2.3 As the Project closing approached, the SC established a Working Group to study and recommend transition mechanisms, the financing of future activities, cooperation arrangements, and the division of responsibilities. The continuation of the activities initiated through the Project was directly due to the close involvement of the SC in Project

23 IEG. 2006. ibid. p. 25.

implementation and the interest that was shown in sustainable management and use of the Guarani aquifer. The significant improvement in the institutional and technical capacity of the four countries, the mainstreaming of groundwater into the national water agendas, and the allocation of budgetary resources, both during Project implementation and after Project closing, are testaments to proactive and successful role that the SC played. During Project execution, counterpart financing reached 127% of the appraisal estimate that clearly demonstrated the wide support and ownership the countries attached to this project.

(b) **Implementing Agency or Agencies Performance**
Rating: Satisfactory.

5.2.4 Implementing agency (or the executing agency) for this Project was the OAS. The OAS (including the PS staff that was contracted for implementing the Project) was able to coordinate the work of different consultants; respond to queries and requests from each beneficiary country; work with the different donors (GEF/Bank, BGR and IAEA); and support the work of the SC. The OAS also partnered with the Bank in harmonizing the two institutions' procedures in financial management, contract awards and applicable operational guidelines and rules. Given the involvement of governments at different levels, the OAS played a critical role in supporting good cooperation and in ensuring the participation of different stakeholders. The diplomatic skills of the OAS was in play in handling some perceived sensitive issues, such as the role of Local Pilot Subproject facilitators. The OAS also strived to maintain balanced staff composition within the PS by contracting from each country and also by benefiting the countries equitably from the internship and twining programs. It also bodes well to the OAS accomplishment that the PS was constituted by high level technical staff from the four countries.

5.2.5 The OAS also partnered with the Bank to proactively seek solution to problems during Project implementation and more importantly for showing unyielding effort in pushing for the need to clearly define and agree on future cooperation arrangements. The OAS experience in international water was also clearly demonstrated during the preparation of TDA and SAP. The OAS Argentina Office Chief, who was responsible for Project implementation coordination, was instrumental in ensuring that SAP preparation reflected the relevant knowledge generated from the vast information collected and that it focused on practical actionable items. The OAS served as a good partner to the Bank throughout Project execution.

(c) **Justification of Rating for Overall Borrower Performance**
Rating: Satisfactory.

5.2.6 Overall the combined performance of the Grant Beneficiary governments and the OAS (the Project executing agency) was Satisfactory.

6. Lessons Learned *(both project-specific and of wide general application)*

6.1 *A regional project by its very nature is time consuming in all phases of the project cycle,* and the water sector brings additional complexity because of the numerous often fragmented responsibilities for government entities at different levels. It is often difficult and time consuming to reach consensus and move forward. Thus, future design of regional water and GW projects should consider a more extended period for preparation and implementation than is normal for a single country project.

6.2 *In the absence of any other existing regional framework, regional projects have to set up their own project implementation framework and determining staff composition is very important.* In the case of the Guarani Project, groundwater coordination mechanisms did not exist in the MERCOSUR[24] region before the advent of this Project, and the institutional framework for the Project had to be developed from scratch including the setting-up of the SC, NPEUs, technical committees, pilot local management commissions and the PS. In the formation of the PS, it was necessary to find a balance among the countries in terms of representation of staff that ensured the interests of each country was well represented and helped in avoiding mistrust among the beneficiary countries.

6.3 *In GW where management is mainly done at the local level, the presence of a local coordinator/facilitator/champion is very important.* Cognizant of the fact that the Guarani Project covers a wide area, the SC, the OAS and the Bank were able to deploy facilitators at the local level that was later found to have been invaluable in terms of coordinating Project activities and organizing stakeholders participation, in the pilot areas.

6.4 *It is important to consider and technically include shallow overlying aquifers in cases where a GW Project is working on a confined aquifer.* At the outset overlying basalt formation aquifers on top of Guarani sandstones were not included in the Project technical and management scope. Although the shallow aquifers have much less storage capacity than the GAS, they are the first in line in groundwater use and need to be analyzed and monitored in order to detect the first sign of stress and contamination before the problem becomes widespread and reaches public wells that are normally deeper. During Project implementation and the technical studies and management frameworks included the integration of shallow aquifers, but it would have been better to have included them from the start.

6.5 *In partnering with an established institution as an executing agency for a GEF project, harmonization of procedures between the Bank and the executing agency is important and should be dealt with early in project preparation and possibly addressed in the Grant Agreement.* In case of the Guarani Project, the OAS (the Executing Agency) was an established institution with its own procurement, financial management and other operational procedures. During Project implementation, it was necessary to go through the different aspects of norms and procedures to align the two institutions' requirements.

6.6 *A regional project should be represented by high level government officials from the relevant ministries of each country to ensure that relevant agreements are made and implemented.* In addition, such a representation by high level officials will greatly support the sustainability of project outcomes after its conclusion, since high officials can commit their country to implement follow-up actions and allocate budgetary resources. The Guarani Project benefited from the participation of high level representatives from three ministries or agencies that provided the forum for dealing with technical, operational and diplomatic issues jointly.

6.7 *A regional project has to continuously engage national line-agency counterparts* and demonstrate the relevance of the project objectives and outcomes to their work programs and institutional mandates in order to garner active engagement and support during project implementation. The Guarani Project was able to demonstrate its importance starting from the beginning that served it well during Project implementation. Once the riparian countries of the

[24] MERCOSUR is a regional trade agreement established in 1991 among the four same countries of GAS to promote free movement of goods, capital, services and people among its member states..

Guarani aquifer realized the importance of the Project's outputs to their work, they shared scientific and technical information and actively participated in developing management approaches.

6.8 *In addition to being a social good, in regard to the provision of good quality domestic water supplies and to meeting environmental objectives, water is also an 'economic good'.* Although there were efforts to undertake such an evaluation during Project implementation, a good analytical and comprehensive study was not carried out. The availability of such a study in the future would improve policy development and could garner the interest of decision-makers at the highest level.

6.9 *The place of regional projects in the Bank and in LCR:* The Bank's experience in regional projects is somewhat limited and lessons learned may not be captured fully given the Bank's focus on country-based interventions. Such projects may be better managed under a regional projects department or VPU office.

6.10 *A regional groundwater project is only as good as the capacity that it creates at the national and particularly at the local levels* because, after all is said and done, uses, contamination, pollution and management of groundwater occurs in space and time at the local level. However, this does not mean that a regional coordination mechanism is irrelevant. Small/light coordination mechanisms will be beneficial. In this regard, one of the achievements of the Project was its ability to clearly identify the role of the different levels in the future management of GAS.

6.11 *For a regional project, a communication strategy should be developed early in project preparation and continuously updated to reflect the changing circumstances.* Using NGOs, civil society organizations and learning institutions, especially those which have a presence at the local level, for awareness building is effective because through time these organizations have developed some credibility in their operational areas. Through the Citizens Fund, the Guarani Project successfully utilized different communication strategy mechanisms and the result was widely recognized as being very positive.

6.12 *Groundwater studies need to clearly identify and delineate areas for conservation, sustainable utilization or mining.* In the Guarani outcropping areas, where the major use is concentrated, sustainable utilization of the resource is possible due to a large amount of natural recharge. However, in confined areas of the Guarani, recharge is low, but storage is very high. Although if well managed the water in these confined areas could last for hundreds or even thousands of years, true sustainable utilization may not be possible (for lack of recharge) and thus the exploitation in these areas after a certain low limit, will need to be treated as mining.

7. Comments on Issues Raised by Borrower/Implementing Agencies/Partners

(a) Borrower/implementing agencies

7.1 The Bank team shared the draft ICR with OAS, BGR and the IAEA. The first two provided a formal comment on the ICR (see Annexes 7 and 8).

7.2 The OAS agreed with the overall Bank assessment of the Project except in rating the Government Performance as Highly Satisfactory. The Organization recommended that the

rating should rather have been Satisfactory. The justification given by the OAS for the lower rating is that the Government performance should be related to the "failure" of the countries in establishing a strong regional institution and to a lesser extent for not requesting extension of the closing date and a follow-up project.

7.3 As stated in the ICR, the project success to a large extent was a factor of the continuous commitment of the participating countries. The SC never failed to support the Project by always taking the hard decisions and sometimes by conducting extraordinary meetings.

7.4 The fact that the Steering Committee opted for a light coordination mechanism is informed and is anchored on the solid findings of the different technical and scientific studies, which firmly established that the management of the GAS is essentially a local undertaking. In such circumstances, what is needed at the regional level is a coordination framework (which the Project successfully established). Strict management should occur at the lower levels in each country.

7.5 The four countries needed to demonstrate to their citizens that they have a sovereign right to the sustainable use and management of the Guarani aquifer. It is therefore rational for the SC not to request funding from the GEF or any other international organization in support of their coordination activities. In fact, although the Bank initially was behind the idea to prepare a follow-up project, the team quickly dropped the idea once it was learned that in general the GAS is basically in a very good condition and that the countries have assumed full ownership of the continuing regional cooperation framework. In addition, the Bank has explicitly communicated that it would have been very difficult to get approval for a second extension of the closing date.

7.6 Finally, during the Quality Enhancement Review meeting, participants were congratulatory to the governments for their ability to establish a coordination mechanism commensurate with the management needs and characteristics of the aquifer. After receiving the OAS comments, the Bank project team revisited the rating, but after reviewing the role the SC played during project execution and the agreed framework for continuing cooperation, the team decided to maintain the Government Performance Rating as Highly Satisfactory.

(b) Cofinanciers

(c) Other partners and stakeholders
(e.g. NGOs/private sector/civil society)

7.7 BGR agreed with the overall assessment of the ICR and concluded that "the execution level of the project is excellent, achieving the results and indicators previewed." (See Annex 8 for detail). The Bank team completely agrees with the comments by BGR. Data and comments provided by BGR were instrumental in improving the ICR.

Annex 1. Project Costs and Financing

(a) Project Cost by Component (in USD Million equivalent)

Components	Appraisal Estimate (USD millions)	Actual/ Latest Estimate (USD millions)	Percentage of Appraisal
1) EXPANSION OF THE KNOWLEDGE BASE	9.91	15.95	160.95
2) DEVELOPMENT OF A JOINT MANAGEMENT FRAMEWORK	7.01	4.79	68.26
3) PUBLIC AND STAKEHOLDER PARTICIPATION	1.31	1.3	98.9
4) MONITORING, EVALUATION AND DISSEMINATION	0.48	0.23	48.37
5) DEVELOPMENT OF MANAGEMENT AND MITIGATION MEASURES IN HOT SPOTS	3.73	3.92	104.99
6) ASSESSMENT OF GEOTHERMAL ENERGY POTENTIALS	0.28	0.01	3.57
7) PROJECT COORDINATION & MANAGEMENT	4.04	5.37	132.92
Total Baseline Cost			
Physical Contingencies	0		
Price Contingencies	0		
Total Project Costs	26.76	31.57	117.97
Project Development Facility/ Block B (PDF/B)	0.54	0.91	165.52
Front-end fee IBRD	0		
Total Financing Required	**27.3**	**32.48**	118.97

(b) Financing

Source of Funds	Type of Cofinancing	Appraisal Estimate (USD millions)	Actual/Latest Estimate (USD millions)	Percentage of Appraisal
Governments		11.99	15.32	127.77
[IBRD/IDA or GEF]		13.40	13.35	99.63
BNPP	[WB-administered TF]	0.1	0.29	290.00
IAEA	[Parallel financing]	0.30	0.63	210.00
BGR	[Parallel financing]	0.60	0.90	150.00
OAS	[Parallel financing]	0.32	0.32	100.00
Beneficiaries	[Parallel financing]	0.05	0.76	1520.00
Total		26.76	31.57	117.97

Annex 2. Outputs by Component

1. Component 1: Expansion and Consolidation of the Current Scientific and Technical Knowledge Base on GAS:

1.1.1 This component supported several studies for consolidation and expansion of the scientific knowledge base on the structure and hydrodynamic behavior of the aquifer and to synthesize and expand the existing knowledge base to meet specific objectives.

1.1.2 The studies resulted in creating new understanding on the dynamics of the GAS that was the main prerequisite for the establishment of a management framework including defining cooperative arrangements among the four countries and bi-national arrangements at the local level. The different studies conducted resulted in important outputs:

(a) Based on a detail study of geology and a technical analysis, the geographic area of coverage of the Guarani was determined to be 1,087,879 Km^2 (or 92% of the original estimation of 1.182million km^2). This improved definition of the area determined the western limit of the GAS that was unknown during Project preparation and also better defined the northern limit of the aquifer; (See Map 1). In addition, the coverage of GAS in each country was determined, as given in the table below.

Table 1: Total surface area of Guarani by country

Country	**Area (km^2)**	**% of total GAS**	**% of country surface area**
Argentina	228,255	20.98	8.1
Brazil	735,918	61.65	8.7
Paraguay	87,536	8.05	21.5
Uruguay	36,170	3.32	19.5
Total	**1,087,879**	**100**	

(b) The large extension of the Guarani aquifer is found in Brazil (constituting 68% of the total area coverage of the aquifer). The 735,918 km^2 area in Brazil distribution among eight states is: Goiás – 39,367.72 Km^2; Mato Grosso – 7,217.57 Km^2; Mato Grosso do Sul – 189,451.38 Km^2; Minas Gerais – 38,585.20 Km^2; Paraná – 119,524.47 Km^2, Rio Grande do Sul – 154,680.82 Km^2; Santa Catarina – 44,132.12 Km^2 and São Paulo – 142,958.48 Km^2.

(c) Ninety-percent of Guarani aquifer water is good quality potable water: In great majority of the aquifer water quality meets potable water standards. Water samples (916—346 in laboratory and 580 "*in situ*") were analyzed in order to characterize the quality of the water in different parts of the aquifer. This study identified areas with four types of characteristics (calcium-bicarbonates, sodium-bicarbonates, sodium-chloride-sulfates, and sodium-chlorides). High salinities (sometimes very high over 3 times the concentration of ocean water) were found in some parts of the aquifer in Argentina. This study also identified areas with relatively high levels of arsenic occurring and in certain areas (from Salto-Concordia up to the boundary of the provinces of Entre Ríos - Corrientes in Argentina).

(d) In terms of population distribution living in the GAS area, as depicted in the table below, the majority of the population of Paraguay (56%) resides in the GAS area, while the

corresponding figure for Brazil is 43%. Around one-fifth of the population of Argentina and Uruguay lives in the GAS area. (See Table 2 below for actual figures.) Overall, at regional level, close to 47% of the population of the four countries live in the Guarani aquifer area. However, out of the total 92 million people settled in the Guarani area, 87% live in Brazil.

Table 2: Total Population living in the GAS region and distribution by country

Country	Population in GAS	% of population of the country	% of population in GAS
Argentina	7,947,667	20.59	8.64
Brazil	80,141,415	42.99	87.04
Paraguay	3,263,318	55.91	3.54
Uruguay	724,768	21.92	0.78
Total	**92,077,168**	**46.67**	**100**

(e) The total water reserve volume within Guarani aquifer is more than 30 trillion m^3 (unlike the original estimate of 40.000 trillion m^3).

(f) The Isotope Studies demonstrated that the Guarani aquifer contains both new water and water as old as 38,000 years. In addition, the existence of very old water in close proximity to the outcropping areas of the aquifer was observed, which indicates that there is very limited lateral movement of water in these areas.

(g) A conceptual model was developed that identified the flow dynamics of the Guarani aquifer and defined four sub-sectors in terms of water flow dynamics and can be treated as subsystems within the GAS;

(h) In general, the capacity of the aquifer and its sustainable yield were better defined – the recharge of Guarani aquifer is estimated to be 5 billion m^3/year and the total reserve stands at 30 trillion m^3. The major user of the GAS water is Brazil at an annual extraction of about 684 million m^3/year. (See Map 3).

(i) Most production wells in the Guarani aquifer have high extraction capacity up to 300m^3/h. On average, a well producing 75m^3/h is considered to be economically and financially viable.

(j) A number of technical manuals were produced to standardize procedure among the four countries and to establish mechanisms that will facilitate the sustainable use of the resource, by reducing potential contamination and overexploitation of groundwater resource. The manuals included: (i) Tube Well Manual;; (ii) Manual on Applied Geophysical Techniques for the GAS; (iii) Manual for Pump Testing;.(iv) Manual for Protection of Wells and Reducing Vulnerability of Contamination of the GAS; (v) Guidelines for Hydro-chemical Sampling and Analysis; and (vi) Guideline for Studying Forest Areas and their Relation to Recharge of the GAS. These manuals have been widely disseminated and are being adopted and used throughout the region.

(k) This component also had additional outputs that added to the information base that will be important in better understanding the GAS environment, including:

(i) Climate change and its impact on the GAS region was partially analyzed. Although precipitation is expected to increase in some areas, temperature increases will be on the order of 3ºC by year 2080 that will result in higher evapotranspiration. As a result, it is expected that some areas of GAS may face a water deficit balance, especially in Paraguay and Brazil between 15^0 and 20^0 South and between 49^0 and 57^0 West, which will increase the value of the Guarani aquifer as a strategic reserve.

(ii) The Project was able to form a consensus among technical specialists in the four countries on what constitutes the Guarani aquifer from the perspective of geological formations. As a result, the GAS is now well defined from geological perspective by identifying the geological formations that comprise the aquifer in the region. As depicted in Table 3 below, these geological formations are: Misiones (in Paraguay) Misiones/Tacuarembo (Argentina), Tacuarembo (Uruguay), Botucatu/Guara, Daturrita and Santa Maria (Southern Brazil) Botucatu and Piramboia (Central and North Brazil) – see Table 3 below.

Table 3: Geological formation that constitute GAS

	Paraguay	**Argentina**	**Uruguay**	**Brazil (South)**	**Brazil (Central-North)**	Section of aquifers
Geological Formation	Alto Paraná	Serra Geral (Curuzú Cuatiá); Posadas/Solari	Arapey	Serra Geral	Grupo Baurú; Serra Geral	Overlying GAS
	Misiones	Misiones (Tacuarembó)	Tacuarembó	Botucatú/ Guará; Caturrita ; Santa María	Botucatú; Pirambóia	↑ 130 millions years GAS 250 millions years ↓
	Tacuary Gr. Independencia	Buena Vista	Buena Vista	Sanga do Cabral	Corumbataí/ Río do Rasto	Underlying GAS

(iii) Geological structures were identified that establish the border between freshwater and saline water in the GAS. The Project determined that there is no clear evidence that establishes the hydrological connection between GAS and wetlands of Ibera (Corrientes province in Argentina)

(iv) It is estimated that the total discharge of groundwater (both natural discharge and extractions by humans) is more or less equivalent to the recharge at the regional level, however, at the local level there are areas where overexploitation was detected and measures were identified to curb the overexploitation in order to achieve sustainable extraction.

(v) The GAS directly discharges into a number of major and small river systems in the region. The discharge to the Parana river is estimated at 0.9-1.8 m^3/s and the corresponding figure for Uruguay river is 7.4-9.8m^3/s.

(l) A study of land use changes that analyzed the evolution during three periods (1980, 1990, and 2007) was conducted using satellite images. The study showed that during this 34 year period the area used for agriculture increased from 22% in 1980 to 47% in 2007; the land allocated to silvopasture increased from 11% to 23% during the same period; dense forest decreased from 9% to 2%; and areas not cultivated decreased from 23% to 18%. These changes in land use could have significant implications for management of the GAS in the future although at this point credible conclusions can not be made on the impact of land use changes on the quality and quantity of the Guarani aquifer water or on the amount of recharge. It is considered likely that plantation forests could significantly reduce recharge and increase water consumption (and eventually decrease discharge) when compared to natural vegetation but with the data and models available it was not possible to quantify this impact or determine if there would be a significant impact on the quality and quantity of the water in the aquifer or in rivers fed by aquifer base flows. A better understanding could be developed following a complete cycle of forestation (from planting to harvesting) that may require 10 to 15 years period depending on the forestry type.

1.2 To provide technical information for evaluation of current and future use scenarios, at the regional level, the Project assessed land use patterns, evaluated existing water use, reviewed the economy of the region and examined population and settlement patterns, among others. Based on these studies and the mathematical model, the Project provided the technical tools to assess future scenarios. In addition, detail socioeconomic studies were conducted in the four pilot areas that provided instructive conclusions for the aquifer management in each locality. The economic valuation (or the economic contribution of the GAS) was not quantified. However, the cost of exploitation, IRR and marginal cost of extracting additional cubic meter of water, under different scenarios, were estimated.

1.3 Currently, GAS is predominantly utilized to supply water for domestic and industrial/commercial use (an estimated 90% of the extraction). Of this, 66% is used for public water supply, 5% for rural water supply, 16% for industrial use and 13% for recreation (thermal tourism). The most diversified use of the Guarani is observed in Brazil, while the least diversification occurs in Argentina where existing wells are used exclusively for recreation/thermal purposes. In Brazil, 44% of the wells are destined for public water supply, 25% for domestic use from private wells, 22% industrial, 7% rural and 2% for recreation. In Paraguay, 96% of the wells are destined for public water supply in urban areas, while the comparable figure for Uruguay is 93%, with an additional 5.7% being used in thermal recreation. The Argentina province of Entre Rios has 15 registered thermal wells that are exclusively used for recreation. (See Map 3)

1.4 The overall conclusion of the socio-economic analysis is that the use of the Guarani aquifer will predominantly remain for domestic and industrial/commercial use either through public water supply systems or private wells. This conclusion is based on the fact that the GW resource was found to be economical, as a source of public water supply, but generally not economical for irrigation use given other alternative water sources. In addition, in the great majority of the region, the GAS is confined. With existing technologies its exploitation is in general not economical, except for thermal recreation.

1.5 The IAEA supported this component by conducting isotope analysis on water samples from 390 sampling points (985 analyses) in Guarani region. An assessment of hydro-chemical and isotope hydrology (18O, D, 14C/13C) and using data from hydro-geology map revealed that the GAS can be divided in to 8 zones with distinct characteristics' in flow and age of the groundwater. However, the three major zones are, outcropping, transition and confined zones. (See Map 4).

1.6 BGR did an excellent job which greatly complemented the Project. BGR conducted a detailed review of the Paraguay pilot area (Itapua) and worked closely with the Project by providing data and study results as they were produced. BGR developed a model for the oriental region of Paraguay including parts of Argentina and Brazil and transferred data and results to the model for the Itapua pilot area that clearly demonstrated the flow dynamics in the pilot area and areas surrounding Itapua. When the Project closing date was extended, BGR also accommodated the Project by extending the closing date of their activities and by financing related activities in Paraguay. BGR is now supporting the integration of Itapua pilot region with basin management activities in the country. BGR also established a database on Guarani aquifer in Paraguay that included an inventory of wells, extraction rates, quality of water, identification of vulnerable areas and related variables. In addition to a number of workshops that BGR organized and/or participated, the following outputs were reported by BGR.

Table 4: BGR products in Paraguay

Field Work	
Hydro census	Information from 350 (deep) wells collected has been compiled and is finally documented.
Hydrochemistry	120Hydrological points were sampled. Full chemical analysis (including non-metallic tracers) by the BGR laboratory.
Groundwater Isotopic Analysis	12Locations were sampled for isotopes e.g. $\delta^{2}H$, ^{3}H, $\delta^{18}O$, $\delta^{13}C$ and ^{14}C
Data banc	2000 Data sets elaborated from the desk studies and from the hydro census (documents, photos, lithological profiles and chemical analysis).
Other activities:	
Digital mapping	Base map and thematic maps
Conceptual Modelling	Interpretation and data compilation
Mathematical Modelling	3-D Groundwater flow simulation model
Reports , web site and PR	www.sag-py.org , reports, flyers + brochures
On the job training	Continuously
Advisory service and support	Continuously

2. ***Joint Development and Implementation of the Guarani Aquifer System Management Framework*** –

2.1 The objective of this component was to develop a framework for the coordinated management (technical, institutional, financial and legal) of the GAS. This framework was to be established within the SAP to be implemented in the GAS region. The SAP was expected to articulate the principal lines of action necessary for achieving the Project's long term objective. This component had five sub-components:

2.2 ***Design and implementation of an aquifer monitoring network:*** The Project selected 180 wells for inclusion in the Guarani aquifer monitoring network that was deemed important for providing data for decision making on the status of the aquifer, to help in identifying emerging problems, and to support the sustainable use and management of the aquifer. A regional commission, composed of experts in the field from the four countries was formed to determine the selection criteria and to decide on the overall establishment of the monitoring network. The commission selected 180 wells (less than the original target of 184 wells) after determining that only less than 10% of the aquifer is found in outcropping areas where most monitoring needs to be carried out given the potential vulnerability of the aquifer in these areas. In areas where groundwater exploitation is showing signs of stress, governments have shown the willingness to include additional wells in the monitoring network. The State of Sao Paulo, for example, has included an additional 22 wells that have increased the number of monitoring wells to 202. Thus, the target was met, and the number wells that will be monitored will increase further given the expressed interest shown by the governments at all levels.

2.3 The Project design planned to install monitoring equipments in these selected monitoring wells. Once it was determined that the flow dynamics in the GAS is very slow, the need for installing such equipment was discounted in favor of periodically monitoring these wells by measuring water depth (or piezometric head) and by taking samples for analyses in laboratories in the region. Some universities (e.g. FUCAI – Catholic University in Itapua, Paraguay) have committed to doing the laboratory analysis in the future.

2.4 In areas where there exists actual or potential overexploitation, the number wells to be included in the regional monitoring network will be higher. For example, in Concordia-Salto, where there is a potential for competitive exploitation of the Guarani for geothermal use, all the 11 production wells presently under operation have been included into the 202 wells selected for the regional monitoring network. (See Map 4).

2.5 ***Development and integration of an information system (SISAG***): Deployment of SISAG was delayed due to several factors including: (i) the decision to first prepare the cartographic map set before embarking on development of the system; (ii) the number of wells (7730) were found to be almost four times the original estimate (around 2000) and thus the collection of the data set (the backbone of SISAG) was found to take more time; (iii) procurement procedures to contract as one package was found to be cumbersome that later was broken-up between hardware and software including training in the use of the system; and (iv) the Brazilian government initiated its own information system and therefore some time elapsed until a decision was made whether to use the Brazilian system for all countries for the sake of compatibility or develop a separate system. The four countries finally determined that SISAG should be developed as a separate system, with linkages to the Brazilian system.

2.6 The original design of the Project identified the preparation of specific technical information such as geological and hydrogeochemical maps for priority areas as part of other technical studies. However, during Project implementation, it was quickly recognized that there was a need to include information collected through the different studies into a geo-referenced cartographic data set. The bidding for the contract to produce these set of maps followed the International Competitive Bidding method and the contract was awarded to the winning firm. However, actual activities of the contract were not initiated immediately due to delays in providing clearance by one of the countries and a formal complaint filed by one of the bidding firms to the Regional Procurement Advisor's office. After reviewing the procedures followed by the OAS/PS, the Procurement Advisor cleared the contract that was signed on January 31, 2005. One-hundred-ninety maps (1:250,000 scale) and one overall map (1: 3,000,000) were produced. These maps were presented to NCs and geographic institutions of the four

countries. This map production utilized a peer review exercise that improved the quality of the map set. The maps were made available to the countries through a web site and will be part of the SISAG. Thus, the Project not only supported the technical preparation of the maps but also involved the institutions of the countries that are future users of the products. Two seminars were held that provided a forum for institutions involved in cartographic work in each country to share their information and provide feedback to the Guarani aquifer maps before they were finalized. The Base Map of GAS won a second place in Best Data Integration category, awarded by ESRI (the company that designs and develops the Geographic Information System – GIS -- technology), in August 2008.

2.7 The implementation of SISAG followed the completion of the preparation of the cartographic map set and was only implemented at the time of Project closing. SISAG is composed of five central servers (one in each country and one for the regional coordination unit in Montevideo) and 28 nodes. The Project initially planned to develop only five nodes/servers. However, the need for connecting the institutions at all levels was determined to be of critical importance not only to share available information but also to provide the platform to update the database by all involved responsible institutions. The Project provided software and hardware and training in the maintenance of the information system and this database is accessible to all participating institutions. At present it includes data from 7730 wells. SISAG also includes the cartographic maps that were developed for the region, which allows for representation of information through a GIS. The database on wells includes depth, year of construction, and amount of extraction of water and the geographic location, and other data. It will be through the SISAG that the 202 plus monitoring wells will be updated to provide information on the status of the aquifer.

2.8 SISAG includes a GIS based database with information on more than 7,000 wells in the GAS region and detail information on several characteristics of the region, including land use patterns, population distribution, potential use of SAG by regions; and spatial 3-dimensional information (geological, geophysical, hydro-geological, hydro-chemical, isotopes, etc.) on the GAS.

2.9 ***Development of Strategic Action Programme (SAP):*** As stated in the PAD, the task of developing the SAP was carried out during the final year of Project implementation to take advantage of improved scientific, technical and institutional/legal information on the GAS that was made available in the later stages of Project implementation. The SAP is an agreed action plan of the four countries. It lays out future forms of management of the aquifer and the cooperation mechanisms, including financing of the activities identified for future implementation. Following the GEF procedures, the SAP was prepared with the participation of citizens, at the technical experts and public policy makers in the four countries and with close involvement by the SC members and NCs. The SAP was approved by the countries in November 2008 and the SC has agreed to oversee the implementation of the agreed actions. The main agreements included definition of institutional mechanisms at all levels, the assumption of specific responsibilities by each country to coordinate follow-up activities; and the continuation of the activities started at pilot level. In terms of specific responsibilities: Argentina will be responsible for the SISAG; Brazil for conceptual and mathematical model maintenance and further development; Paraguay will coordinate training and capacity improvement activities, and Uruguay will house the newly reorganized coordination unit. The countries also assumed the responsibility to coordinate follow-up pilot Project activities: Argentina for Concordia-Salto; Uruguay for Riveira-Santana[25]; Paraguay for Itapua and Brazil for Ribeirao Preto.

[25] Santana in this document refers to Santana do Livramento in Brazil.

2.10 The SAP is under wide dissemination around the region and beyond. Specific agreed actions include:

(a) Update and maintain the database and SISAG to serve as decision-support system;
(b) Maintain and further develop the GAS monitoring network and continued development and use of the mathematical models
(c) Recognize the role of Local Commissions in Support of GAS management in the pilot areas and to replicate lessons learned from these pilots in other areas where the Guarani aquifer demonstrates similar characteristics and problems;
(d) Widely disseminate the knowledge generated through the Guarani Project and develop the capacity of institutions of the countries in the management of GW;
(e) Ensure that public participation in the process of decision making is maintained and provide priority to awareness building on environment and on the value of GW, especially on the GAS aimed at enhancing effectiveness of GW management;
(f) Develop and implement shared principles for the sustainable use of the GAS with specificity for different zones, especially in the recharge zone;
(g) Implement technical and scientific programs especially in the thematic areas considered to be strategic for the management and protection of the GAS;
(h) Conduct an economic and environmental evaluation on the actual and future use of thermal and non-thermal use of the GAS
(i) Generate technical and institutional capacity for the management of GW in coordination and within a regional arrangement;
(j) Support the operational structure established for coordinating the activities of the four countries.

2.11 Institutional Strengthening: In addition to benefiting public water and environmental agencies in each country, the institutional strengthening activities benefited NGOs, learning and other public institutions and private operators of wells. In terms of direct hands-on training, a total of 44 staff from the four countries benefited from internships, out of which 9 were twinned with consulting firms that were conducting technical field work and studies and 35 benefited through the internship program established through the Project. The Project also provided several training in specialized field, which is summarized under Table 5 below. In addition, 75% of the consultants that worked for the consulting firms contracted to conduct detail scientific studies were professionals from the region thereby contributing to improving the in-country capacity of the four countries.

Table 5: Selected training workshops provided by the Project

Course/provider	No of institutions	No of professionals
Groundwater management – GWMATE	137	216
Digital cartography	59	101
Cap-NET (technical operation of wells, integrated water resource management, public participation and technical demonstrations)	252	296
IAEA (training in isotope analysis)	Unknown	344
Training in Guarani data systems	22	32
Workshop on geology and geo-physics of Guarani	40	51
Hands-on training on the Guarani groundwater monitoring network	50	55
Sustainable use of Guarani groundwater	72	76
Introduction and calibration of conceptual models of SAG including pilot areas	27	37
Use and understanding of hydrogeology map of GAS	7	7

2.12 Through this subcomponent, the BNWPP supported the establishment of University Fund in the region to carry scientific studies in specific localities on specific themes related to the Guarani aquifer. Nine subprojects were selected out of a total of 29 proposals presented for funding. These nine studies covered three major thematic areas: (i) enhancing the existing knowledge base on point and non-point sources of contamination of the GAS; (ii) evaluation and assessment on the vulnerability of Guarani aquifer; and (iii) studies on recharge and discharge areas to identify areas that need protection. The result of these studies were published and widely distributed across the region. In addition, following the need for cooperative management of the Guarani aquifer, the nine subprojects supported through the University Fund were implemented jointly by two or three universities. A total of 21 universities and four public research institutions from the four countries were associated to conduct the nine studies. The main findings of the studies financed under this fund are available through the Project website: (http://www.sg-guarani.org/index/site/proyecto_particular/pp003b.php)

2.13 Four of the studies were carried out in areas identified as "hot spots" with a potential for conflicts with bordering countries and where signs of stress were evident. Because this Fund made possible the mainstreaming of GW into the academic agenda of the institutions, the activities initiated through the Grant will continue into the future ensuring the sustainability of the outcomes. The universities also will play an active leadership role in providing the necessary information for decision making and in monitoring of the resource into the future unlike the pre-project phase where data and knowledge was limited, scattered and unshared. Some of the initiatives undertaken under the University fund resulted in additional financing. The Government of Rio Grande de Sol, for instance financed the installation of stations for monitoring the region's environment.

2.14 As mentioned above, BGR and IAEA contributed to institutional strengthening. IAEA provided training on isotope analyses that increased the capacity of several institutions and professionals in the region and provided equipment to help institutions involved in GW management to carry out their activities. Twenty-one hydro-geologists benefited from the training provided by IAEA. BGR supported the new Guarani Unit in Paraguay by providing vehicle, field equipment for hydro-geological investigations, computer facilities, intranet and internet linkage and mapping and modeling software and continuous on-the-job training for at least several Ministry of Environment staff and supported two master level studies and three specific trainings in higher education.

2.15 Overall, institutions in the four countries at all levels are benefiting from the improved and dependable knowledge base on the Guarani aquifer, tested management practices and manuals for different technical aspects, improved information systems (software-and-hardware) working models, and trained staff, among others. In addition, the fact that the Project resulted in a well informed populous, in regard to the need for groundwater management also facilitates the work of the institutions.

2.16 ***Transboundary Diagnostic Analysis (TDA):*** As a GEF supported international water project, the Guarani Project developed a TDA through extensive participation of different segments of the population. The TDA was approved and accepted by the countries following intensive discussions conducted in each country through the facilitation of the NCs of each country. The TDA identified critical root causes in the future sustainable management and use of the Guarani aquifer and identified the following elements that later became the basis for the preparation of the SAP.

(a) The TDA developed a framework for analyzing causes of critical issues and possible mitigation measures. It classified the causes as: (i) natural – caused by climate change,

topography or soil type which in general is not amenable to mitigation measure; (ii) primary or technical – resulting from low level sanitation coverage, unsuitable well construction/perforation, destruction of vegetative cover; (iii) secondary or economic management – caused by attaching low value to environmental benefits, lack of priorities and uncontrolled use of GW, among others; (iv) tertiary or political – mainly due to lack of legal norms, absence of managing institutions; and (v) fundamental or socio-cultural – resulting from lack of public participation and low level of capacity and limited awareness.

(b) The TDA made some critical observations in respect to the need to strengthen public organizations responsible for the management, technical training and administration and made the recommendation to undertake activities that lead to improving: (i) the efficiency of institutional arrangements at the local level; (ii) the capacity of environmental and water regulatory agencies to take preventive measures rather than reactive measures after conflicts occurs; and (iii) the participation of users among the different sectoral organizations in the use and risk management in GW. In addition, the report confirmed the need for reviewing the legal regime for the management and protection of GW in the different national, provincial and state levels in the Guarani region to identify the strength and weaknesses in implementation of actual and future protection of the Guarani aquifer. In regard to the pilot regions, the preliminary report identified key results expected in each pilot subproject.

2.17 It has to be noted that the TDA was conducted before the different technical studies were completed. Therefore the TDA reflected available knowledge during the time and the general perceptions about the aquifer. Hence, some of the conclusions of the TDA were later found to lack a scientific basis. For example, the TDA was not able to appreciate the fact that existing legal frameworks in each country were sufficient for the management of the aquifer needing only the strengthening of enforcement mechanisms. In addition, it did not reflect very well the fact that management of the GAS is essentially local in nature.

3. Public and Stakeholder Participation, Education and Communication

3.1 Design of a Regional Communication and Public Participation Plan*:* During Project preparation this became an important task when the Project was forced to deal with a negative campaign that was undertaken by certain groups. The Project quickly prepared a communication strategy with the support of the Bank's external relation department professionals. It was important to undertake this activity immediately to avoid the possibility of derailing the Project from its main tasks. However, some significant time was lost until a person responsible for this task was brought on board in the PS. Initially technical staff needed to allocate additional time to communicate Project objectives. In addition to the systematic implementation of the communication strategy, what also helped was the forum the Project created for participation. Stakeholders participation was formalized at all levels: At local pilot areas NGOs, universities, citizen representatives, line-ministry agents and private sector representatives were brought on board into the local management commission created as part of the pilot subprojects.

3.2 The Project also attracted a large amount of coverage by news media in the region, especially in print media. Although initially the coverage was negative, it quickly changed and started to focus on the need for sustainable management of the resource. The Project also developed a communication channel with Environmental journalists.

3.3 To help craft a strategy for public participation in GW, the PS organized a workshop, which assessed the experiences of the Guarani Project and where lessons learned were extracted.

The review exercise and its conclusions and recommendations later contributed to the formulation the SAP's public participation mechanism.

3.4 ***Establishment of Citizen Fund:*** The Citizen Fund supported 24 subprojects of which one was not completed. A total of 2.3 million people are estimated to have been reached through the activities of this fund that implemented subprojects that educated the public on groundwater management issues trough distribution of learning materials and conducting communication campaigns. These subprojects were implemented by NGOs, universities and civil society organizations that proved to be an excellent mechanism to reach the population at large since these organizations have established credibility in their communities. The successful implementation of this task enhanced public understanding about the Project objectives at the local level. Selected materials produced through this fund (21 out of 24) are available for downloading at the Project web site, which has registered an average of 3,600 downloads per month. (http://www.sg-guarani.org/index/site/proyecto_particular/pp003b.php).

3.5 Overall these subprojects were evenly distributed among the four countries and some were implemented as joint ventures. The fund focused on pilot regions – out of the 24 subprojects, nine were in pilot regions (four in Concordia/Salto, two in Rivera/Santana, one Ribeirao Preto and two in Itapúa) and six were operational in transboundary areas. The beneficiaries of this fund were: 14 socio-environmental NGOs, nine universities, four professional associations and two local representatives of public organizations. In addition, there were two subprojects that were specifically geared to reach the indigenous community that trained local environmental promoters and transmitted awareness building and educational messages using the Guarani language.

3.6 The central theme of the large majority of these subprojects was diffusion of knowledge and training of educators and civil society organizations. Some subprojects also dealt on gender/groundwater issues. The training and educational materials produced by the recipients of the fund are considered to be of high quality by the PS, the OAS and by the professionals in the region.

3.7 ***Creation and dissemination of instruments to increase awareness, interest and commitment among stakeholders***: The Project Secretariat created a monthly newsletter which reached 4100 subscribers in its distribution list and since the initiation of this medium, a total of 70 newsletters were produced. The web site of the Project became a good source of information on the Project and was very transparent in sharing important information developed through the Project. The web site, on average, had 23,000 visitors per month. As part of the communication strategy, the Project produced posters, leaflets and video clips on the Project objective and on the need for sustainable management of the aquifer. These materials were widely distributed by all agencies participating in the Project. The Project also developed "TV spots" in cooperation with the media but without cost to the Project, which were transmitted through TV and Radio in each country that reached an estimated 2.6 million people. In addition, the countries carried out their own communication efforts in support of the Project once it was determined that the NPEU should help in this task. At the pilot area level, local facilitators were the main driving force in communications. Some localities produced their own communication video clips independent to the Project that were transmitted through local media outlets.

3.8. ***Preparation of Indigenous people's strategy***: As planned, during Project preparation, the PS informed national indigenous people organizations in Argentina, Brazil and Paraguay on the

advances made in Project execution. Later on the Project supported the preparation of an indigenous people's strategy that is now accessible through www.sg-guarani.org/indigenas.

3.9 In addition to the development of the indigenous people's strategy the Project helped achieve two main results: (i) strengthened the link among indigenous people organizations (such as INAI, Argentina; FUNAI, Brazil, INDI, Paraguay) and indigenous communities on the one hand and institutions involved in water resource management at different levels, on the other hand; (ii) in addition to providing information to the indigenous community leaders on the GAS, the Project supported the inclusion of indigenous people issue into the SAP. Also, as part of the indigenous people's strategy, the Project focused on what is relevant to these target groups, such as building awareness on the use of clean water and thus has contributed to future health improvement of these communities.

3.10 Further, the Citizens Fund supported two subprojects that trained trainers to enhance awareness within the indigenous community and prepared relevant documents in indigenous languages for distribution and use within the community and the school system.

4. **Project Monitoring and Evaluation, and Dissemination of Project Results (US$0.48 million or 1.8%)**

4.1 During Project implementation, the PS was able to deploy an information system for the management of Project implementation (*Sistema Informatizado de Gestión del Proyecto* -- SIGP). This system allowed for monitoring of Project implementation and provided updates for SC meetings and Bank supervision missions. In addition, the system was instrumental in monitoring annual work plans, financial management, procurement processes and timetable and for accounting counterpart contributions. However, the system did not benefit from updates from different Project activities since some of the indicators only started to be realized later in Project implementation phase. For those that were monitorable, the system provided information on the status of the advances made in Project execution.

4.2 In addition this component supported the dissemination of Project products. However, the issue of import taxes delayed the distribution of the results of several scientific studies, especially in Brazil. Using the OAS offices in the region and each country, dissemination work was later enhanced. The Project also partnered with other agencies in groundwater to help its dissemination activity.

5. **Development of Management and Mitigation Measures within Identified "Hot Spots"**

5.1 Four 'hot spots' were selected to pilot local management in the GAS region. In these areas detailed studies on the aquifer characteristics and the related socioeconomic variables were conducted. The pilot regions were selected to represent areas of the GAS with actual or potential problems in overexploitation, and/or pollution/contamination and were identified as potential areas for conflict and competition in the use of GAS. Two were transboundary (Rivera, Uruguay /Santana, Brazil; and Concordia, Argentina /Salto, Uruguay) and the other two were located in a single country (Ribeirao Preto, Brazil and Itapua in Paraguay). In each pilot area, the Project first established a Local Management Commission composed of several agencies and stakeholders. Later these commissions were transformed into 'Support Groups for Local Management of the GAS.' These local commissions now have an improved understanding the Guarani aquifer, which was made possible through different training workshops (groundwater management, isotope analysis, measuring flow mechanisms, communication strategy, citizen participation, well drilling, water quality monitoring, information system utilization and updating, etc).

5.2 The Project deployed information systems, provided office equipment and instruments for field work (such as water quality measurement devices and GPSs for geo-referencing of wells and other potential pollution sources) which will be instrumental in the future for monitoring and updating of the database. The mathematical models developed for each pilot area will be the main tool for deepening the understanding on the dynamics of the Guarani aquifer in the local areas and will support simulation of different scenarios for use and management of the aquifer to better inform decision-making. Thus, significant progress has been made in creating and strengthening the institutional basis for the future management of the aquifer in the pilot areas.

5.3 The pilot areas has come a long way in terms of managing the GAS – controlling contamination and pollution, such as lining of solid waste sites in Rivera; managing the risk of overexploitation, such as in Ribeirao Preto and Concordia/Salto and monitoring agricultural discharges, such as in Itapua. At the pilot level local monitoring networks will be maintained as a part of the follow-up activities to the Project.

5.4 In two pilot sister towns (Rivera-Santana and Concordia-Salto) there is a potential risk for conflicts caused by contamination or competitive exploitation and the Project supported significant reductions in these risks through cooperative management actions. Before the Project, these sister towns did not know the number of wells operating and/or the level of extraction in each other's localities and there was also almost no information on GW quality and pollution. At present they have an information system with all the relevant data on each other's wells characteristics, water quality, level of extraction, and other relevant data for monitoring the aquifer. Such sharing of detailed data and monitoring, and the creation of the information system played a catalytic role in building trust among the different countries at all levels thereby reducing the possibility for future conflicts. The two pilot areas have also adopted a series of measures related to well locations and spacing, sanitation, and solid waste management which significantly reduce the risk of contamination and overdraft.

5.5 Itapua pilot region became the primary region in the country where the new water law regulations are being implemented. Through the support of BGR, the function of the pilot region in Paraguay, Itapua, is now integrated into the basin committee where there is a strong intuitional basis that include a local university and NGOs with a reputation within the community.

5.6 The Project supported detail scientific studies on the different aspects of the Guarani aquifer at the local level including socio-economic analyses. Several instructive conclusions emanated from these detail studies:

(a) in Ribeirao Preto, under a business as usual scenario, the groundwater resource could be totally depleted by 2030. Taking this into account, the Project in cooperation with the state government: (i) established the importance of intensive monitoring, (ii) delineated areas for protection, (iii) identified areas where new wells perforation should be prohibited; (iv) mapped areas where new wells could be constructed, (v) planned for implementation of a demand management program including leakage control, micro-measurement and tariff raising, and (vi) planned for analyzing other surface water and groundwater sources of water in addition to the Guarani aquifer that is presently Ribeirao Preto's only water supply source;

(b) in Concordia (Argentina) and Salto (Uruguay) the studies determined that established that the aquifer has no hydraulic relationship with the freshwater of Paraguay river and intrusion of salt water is not a significant risk. However, because recharge is practically non-existent, there is a

danger of greatly reducing the piezomteric heads in the confined Guarani aquifer if the two sister towns embark on competitive exploitation of the geothermal water. They therefore: (i) established the minimum distance necessary between geothermal wells; (ii) emphasized the need to limit the total number of wells and amount of extraction from each well; (iii) highlighted the importance of recycling geothermal water after its use in recreation/tourism; (iv) supported the agreement reached between the two localities in adapting similar standards in well perforations; and (v) include all operating wells in GAS monitoring network.

(c) in Riveira-Santana: in general, there is no problem of contamination of the Guarani GW in this locality. However, some samples showed somewhat elevated concentrations of nitrates or other chemicals (but still within acceptable limits). Also, although there is no perceived overdraft in the pilot area, the mathematical model indicated that there is potential for overexploitation in the future without adequate management and controls. Given the low coverage of sanitation services (40% of the population in Santana and 30% in Rivera), the observed preliminary detection of quality problems, and the potential for future overexploitation, the Project determined that there is a need to: (i) improve solid waste management and sanitation coverage; (ii) monitor water levels and water quality and operate and maintain the local Guarani aquifer monitoring network, given that the aquifer is the main source of water supply for the population of the two sister towns; (iii) register and monitor private wells; (iv) locate new wells for public water supply in new protected areas in the two localities and establish a perimeter to protect the wells including land use restrictions; and (v) create a central location for the local commission that will facilitate public participation.

(d) in Itapua, Paraguay, This pilot region is characterized with 50% basalt overlaying and the other 50% with Guarani sandstone outcropping area. There are more than 60 registered operating wells in this pilot region that have between 70 to 120 m depth in the Guarani aquifer and reach up to 300 m in the basalt covered areas. The pilot region is located in an area where cultivation and livestock is the main economic activity. In addition, there is a plan to help farmers to intensifying their farm. The specific critical issues in the management of the GAS in this pilot area are related to: (i) possible contamination of drinking water supply wells from inadequate sanitation, unplanned land use, and inadequate use of agro-chemicals; (ii) hydrological balance related to forestation and its potential impact on recharge; and quantity and quality of recharge to the aquifer that is affected by intensive agriculture and the system of cultivation. Thus, the Project identified the following activities for management of GAS in this locality: (i) protection of the source of municipal water supply by establishing a perimeter for the protection of these wells; (ii) evaluate the use of Guarani water for supplementary irrigation by first improving the capacity of the local university and then developing a demonstration plot for evaluating the processes of agricultural related contamination; (iii) develop a program for expanding the knowledge base on the local characteristics of the aquifer; (iv) improve the capacity of local institutions including learning, public and private institutions; (v) establish a local sub-committee under the local commission for communication, awareness building, and updating of scientific knowledge; and (vi) establishment of a center for public participation.

5.7 In addition, the Project accomplished the following in the pilot areas:

(a) collected available information related to Guarani aquifer in their respective regions including digital maps, inventory of wells, studies on the local characteristics of the resource and chemical analysis of different water wells;

(b) enhanced dissemination activities about the Project and the aquifer, as well as the need for its sustainable management through: (i) media outlets that included radio, TV and newspapers; (ii) workshops and local forums; (iii) locally produced video; and (iv) local web sites;

(c) expanded cooperation with relevant institutions and incorporated additional stakeholders in the local management commissions;
(d) provided representation of the Guarani Project in local basin management committees;
(e) strengthened the collaboration between transboundary agencies – in case of the Concordia/Salto pilot region a memorandum of understanding was signed to coordinate their local actions in the management of the resource;
(f) supported and championed tangible action to mitigate adverse impacts through control of deforestation, creation of ecological parks, delineation of areas for protection, for well drilling and for reforestation; .and finally
(g) developed a local management plan as part of the SAP that can be called Local SAP.

5.8 The facilitators that were later brought on board by the project, played a critical role in coordinating stakeholder cooperation by facilitating a regular meeting of stakeholders and pilot area local management commissions and by ensuring transparent information flow among the commission members. The facilitators and pilot commissions were instrumental in supporting the work of consulting firms, in dispelling inaccurate information, and in improving awareness. The facilitators also prepared periodic reports on the status of Project implementation and cooperation in the pilot areas.

5.9 In summary, a detailed study was carried out for all pilot areas to understand the dynamics of the GAS in each locality. The institutional basis was established and relevant trainings were provided to help in the management of the GAS in the specific localities. The lessons drawn from the experience in these pilot areas is now readily available to be replicated in other hot spots. The Guarani Project has identified three such new pilot areas for replicating the lessons learned from these pilots. These three pilot areas are (i) the surrounding zones of the town of Artigas (Uruguay)-Quarai (Brazil); (ii) Pedro Juan Caballero (Paraguay)/Ponta Pora (Brazil); and Tres Frontiera region (Brazil/Paraguay/Argentina). Through the support of BGR work has already began at the second pilot region that is shared between Brazil and Paraguay.

6. Assessment of Geothermal Energy Potential

6.1 This component supported a detailed study of the hydro-thermal potential of the Guarani aquifer. It is now determined that the groundwater temperature of the SAG is between 25^0-80^0C. This signifies that the Guarani aquifer's potential as an alternative source of energy is limited to certain activities, such as geothermal tourism, heated greenhouses, drying of various products, such as wood and other agricultural products, fish farming, space heating of houses and buildings, among others. Based on temperature, the Guarani aquifer geothermal potential was classified into three zones. Table 6 shows the 3 zones and the potential use in each of the three zones.

6.2 Some professionals in the field made the view that the Project should not have had a geothermal component aimed at alternative energy sources. However, what the critics miss is that it is only during Project implementation that it was determined the temperatures from the thermal water were not high enough to economically develop the aquifer as an alternative source of energy.

Table 6. Identification hydrothermal zones and possible uses.

SAG Hydrothermal Zones	Current use in SAG	Potential Use
Zone 1- (<30ºC)		Geothermal heat pump, soil heating, fish farming, temperature control, cooling and heating of homes, water heating, water parks;
Zone 2- (30ºC - 50ºC)	Tourist Use / Salto-Concordia Hydrothermal Zone	Mushroom growing, beverage carbonation, greenhouses and soil sterilization, fish farming, cement curing, water parks, freezing control, cooling and heating of homes, water heating, pasteurization, chicken peeling;
Zone 3- (>50ºC)		Drying fruits and vegetables, beverage carbonation, greenhouses and soil sterilization, processing Wood and paper pulp, cement curing, food processing, freezing control, cooling and heating homes, water heating, pasteurization;

Source: Adapted from the report of the evaluation of potential of thermal and non-thermal uses of GAS water, Consorcio Guarani, 2008.

7. Project Coordination and Management

7.1 The Project Secretariat that played the traditional role of PIU was structured to be the Project operational. Under the management of the OAS, the PS was responsible for coordinating the different consultant activities, that included the preparation of terms of reference and RFPs, procurement/contracting, administration of the contracts, and monitoring and verifying the products. The PS also procured equipment, carried out financial management, and coordinated the day-to-day Project implementation activities. The PS successfully conducted dissemination of Project results using different medium, coordinated communication activities, supported the work of the SC, the Bank and other partners, prepared annual reports and plans, and closely coordinated the work in the pilot areas. Given the number of institutions that were involved in the Project and the area covered, the PS did a very good job of Project implementation and coordination with many pressures from different corners.

7.2 The PS was staffed with capable technical professionals from the four countries who were instrumental in analyzing the different consultants' products, conducting awareness building, and coordination of technical peer reviews. The PS dedicated a considerable time in coordinating consensus building effort regarding the detailed implementation of the Project across multiple stakeholders in the four countries. The different training workshops and institutional capacity improvement activities that were implemented through the Project were also coordinated by the PS. The staff of the PS were active in sharing outputs with stakeholders in the region through workshops and training events and the Project web site. The PS also supported the establishment of local pilot offices and managed the provision of office equipment, such as computers, to the four pilot regions.

Annex 3. Economic and Financial Analysis
(including assumptions in the analysis)

Not Applicable.

Annex 4. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Luiz Gabriel Azevedo,	Sector Leader, Environment	LCSES	TTL
Karin Kemper	Sr. Water Resource Specialist	LCSAR	TTL
Michael Carroll	Sr. Agriculturalist	LCSAR	Team Member
Alexander Bakalian	Water engineer		Team Member
Teresa Roncal	Procurement Analyst	LCSES	Team Member
Supervision/ICR			
Fabiola Altimari Montiel	Sr Counsel	LEGLA	Team Member
Stephen Foster	Consultant	ESDGW-HIS	Team Member
Hector Garduno	Consultant	ETWWA	Team Member
Ricardo Hirata	Consultant	LCSUW	Team Member
Sergio Alvaro Jellinek	Communications Advisor	LCREA	Team Member
Efraim Jimenez	Consultant	EAPCO	Team Member
Jorge Kamine	Counsel	LEGLA	Team Member
Ricardo Eduardo Lugea	Procurement Specialist	LCSPT	Team Member
Fabienne Mroczka	Financial Management Analyst	LCSFM	Team Member
Luis M. Schwarz	Senior Finance Officer	LOAFC	Team Member
Samuel Taffesse	Operations Officer	LCSAR	Co-TTL
Douglas Olson	Lead Water Resource Specialist	LCSEN	TTL
Karin Kemper	Sr. Water Resource Specialist	LCSAR	TTL
Abel Mejia	Sector Manager	LCSEN	TTL

(b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	USD Thousands (including travel and consultant costs)
Lending		
FY00		116.32
FY01		103.41
FY02		113.06
FY03		7.34
FY04		41.45
FY05		5.98
FY06		0.00
FY07		0.00
FY08		0.00
Total:		387.56

Supervision/ICR		
FY00		0.00
FY01		0.00
FY02		0.00
FY03		38.24
FY04		77.78
FY05		64.22
FY06		71.81
FY07		71.68
FY08		101.23
Total:		424.96

Annex 5. Beneficiary Survey Results
(if any)

Annex 6. Stakeholder Workshop Report and Results
(if any)

Annex 7. Summary of Borrower's ICR and/or Comments on Draft ICR

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ORGANIZATION DES ETATS AMERICAINS
ORGANIZATION OF AMERICAN STATES

Buenos Aires, July 8, 2009

Mr.
Douglas Olson
Task Manager, Guarani Project
World Bank

Dear Mr. Olson

Following the World Bank request to revise the draft document prepared for the *Implementation Completion and Results Report* (TF-50950 TF- 51223), for the *Environmental Protection and Sustainable Development of the Guarani Aquifer System* Project, as it Executing Agency, please see attached the Department of Sustainable Development of the OAS comments for the World Bank consideration. As you can see, at the end of the Project implementation phase there is a clear coincidence in the SG/OAS evaluation with the main World Bank assessment of the Guarani Project results.

Sincerely

Jorge Rucks
Chief, Division II (Water Management)
Department of Sustainable Development
Organization of American States

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ORGANIZATION OF AMERICAN STATES

Annex 7. GS/OAS Comments on Draft ICR.

The Department of Sustainable Development of the General Secretariat of the OAS (OAS-DSD) was the Executing Agency responsible for the implementation of the project, as defined in the multiple converging agreements signed with the participating countries and approved by the GEF, through the World Bank. In this role, DSD maintained a close working relationship with the managers and staff assigned to the Project by the World Bank, and coordinated the different actors involved in project implementation. To formalize and provide a legal basis for working relationships, legal instruments were signed with the governments of the 4 countries, as the main beneficiaries of the project, and with the World Bank, as a GEF implementing agency, working in close collaboration with co-financing agencies and organizations, like the BGR of Germany and IAEA.

As part of its managerial and coordinating role, and in accordance with the Project Document, OAS/DSD set up and provided support to the General Secretariat of the project in Montevideo, Uruguay.

The fact that GS/OAS was selected as the Executing Agency of the project is indicative of a key factor in evaluating a project of regional nature in these 4 countries: governments did not have an adequate regional institutional framework to house a project with the characteristics of the Guarani Aquifer System (GAS) project. Therefore, the summary indicator of success for the Project is the **sustainability** of the actions initiated by the project, given the lack of institutional framework for mutual cooperation toward the protective management of the GAS. To assess this indicator it is necessary to recognize that the specific objective sought by the project was to attain the **"technical, legal and institutional framework for the protective management of the Guarani Aquifer System."** The interest of governments in the sustainable management of the GAS is expressed in the decisions objectively taken for the continuity of activities and by the management tools assembled by the project at different scales of action.

The evaluation (ICR) proposed by the World Bank is fully coherent and consistent with DSD's assessment in almost all aspects and indicators. This is logical given the strong and close working relationship established by the staff involved in the project from both agencies, the adherence and respect to the respective roles of implementing and executing agency, to the constant consultations and exchange of ideas on key issues indicative of project's progress, and to the respect for established procedures and regulations. This resulted in a high level of professionalism, and positive understanding between the inter-agency partners, which ultimately lead to a high level of confidence of the beneficiaries.

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DSD/OAS agrees with the draft ICR proposal submitted by the World Bank, recognizing PSAG performance as "satisfactory", with partial contributions towards the enrichment of transboundary aquifer management. The undertaking of the project was an advanced initiative in the global environment that redeemed the notion of preventive-protective as a unifying factor and acted as a catalyst for mutual cooperation between the four countries.

The project progressed with the governments and institutions of the countries in the affirmation, based on scientific and technical bases, on the understanding of transboundary concept applied to groundwater management, asserting the sovereignty of each country to their resources, the need for local management, and the essential involvement of actors in these fields.

The execution of the project reaffirmed the appropriateness of its design during preparation phase, as it was not necessary to introduce substantive changes to the agreed upon technical or institutional arrangements. Extension of the execution period was generated by procedural factors, not by breach of responsibility or technical failures.

From the time of the project's preparation through the end of its execution profound transformations in the legal and institutional frameworks for the management of groundwater took place in the region. The project, and its adequate integration of the four countries involved, was a determining factor of these legal and institutional changes, at national, sub-national and local levels. The project also served as a tool that provided basic information, which was managed transparently and opened spaces of trust when myths and misinformation regarding the GAS were generated that, among other unclear motives, sought to discredit the project. However, the use of inalienable principles by these groups as the issue of sovereignty over their water resources, and the biased handling of related information, led to uncertainties in key moments of the project, which conditioned the decisions of key actors and limited the consolidation of their achievements.

It is in the rating of "highly satisfactory" performance for the governments where the DSD¡/OAS differs from the World Bank proposal, and proposes that the rating be "satisfactory." If the final indicator of success that summarizes the project's achievements is **to have a technical, legal and institutional framework for the management of the protected Guarani Aquifer System**, that ensures the sustainability of achievements, even though the "management framework" was assembled and approved in the SAP, steps to ensure the that management tools be institutionalized and assembled on a regional level were not taken in time. The willingness of governments to continue the mutual cooperation for the regional GAS would have been very satisfactory if, one year before the project's completion, the governments had either requested a project extension or a new project altogether in order to consolidate the generated instruments without endangering continuity. At the time the World Bank and the OAS/DSD agreed on this need, and alerted government representatives of the problem and the proposed alternatives, which were not considered.

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OAS/DSD recognizes that it is "very satisfactory" that governments made internal decisions for the sustainable management of the GAS in each country. This coincides with the World Bank's assessment that the regional cooperative action is complementary to national, sub-national and local management in each country. However the project advanced in the development of instruments at the regional scale which are crucial to water security in the region of the GAS and therefore for each country, including:

- Capacity building for groundwater management. Lack of skills was one of the most important gaps identified in the Project's TDA; its solution is more efficient and realistic in the context of regional cooperation. This aspect was included in the SAP, led by Paraguay, but without the support needed to carry it forward.

- Monitoring and evaluation of the resource was mounted on a Regional Monitoring Network for the GAS, addressing regional vulnerabilities of the aquifer system. The network requires inter-institutional coordination and mutual cooperation to maximize effectiveness. The maintenance and operation of this network was included in the SAP and was to be managed by Brazil. However, legal and institutional bases for its operation are still required, subordinating this activity to the implementation of a regional institutional support mechanism, which the four countries have not agreed upon to date.

- The SISAG was assembled with personnel trained at each country and in conditions to operate as a regional system, but is not operating according to the imputing of data from each of the actors involved. Its operation and functionality was managed by Argentina, in an extemporaneous decision by the CSDP at the time SISAG was assembled with a central node in Uruguay, and where the equipment was allocated. There are funds to operate the SISAG at regional level with a center in Argentina, but the enabling institutional arrangements have yet to be decided upon.

- Local management experiences, particularly the two clearly transboundary areas (Concordia-Salto, and Rivera Santana do Livramento), lack the institutional and legal support needed to ensure its continuity. The SAP includes proposals that require time and capacity for effective implementation.

- With advances in local and regional knowledge of the GAS, conceptual and mathematical modeling was developed and a digital base map was prepared. To the extent that knowledge is advancing, maps and models need to be enriched and adjusted. Such updates relate to monitoring and information management. The updating of these tools for decision-making was also proposed to be managed by Brazil, with the same constraints for work at the regional level.

- Finally, in the SAP it was agreed that a Regional Coordination Office with a minimal technical capacity should be maintained, with its headquarters in Montevideo, for which

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the Government of Uruguay has pledged support. This has been arranged at the end of the project but has no real chance of functioning, as the necessary platform of a regional institutional framework is not yet in place.

In conclusion, although it is noted as "high satisfactory" the fact that in order to implement the Immediate Phase of the SAP, two of the countries, Argentina and Brazil, incorporated funding for national, sub-national and regional cooperation in the GAS, and that Uruguay provided the headquarters for the operation of the Regional Coordination Unit, there was not sufficient time to adjust the institutional arrangements that would have made possible the planned regional execution with available funds. Uncertainty remains with regard to solutions proposed by governments, which is a risk in the future. OAS/DSD recognizes the healthy interest of countries to take direct action for mutual cooperation for the management of the GAS at the regional scale, but understands that the region lacks an interface to consolidate what the project advanced at this level, and that this was recognized in the claims of sub-regional bodies and local civil society organizations in the final SAP consultations.

The progress achieved by the project in the public consciousness and the ownership of its objective by national, sub-national and local institutions confirms that the project effectively advanced appreciation for the GAS, which will not recede.

In synthesis, OAS/DSD assesses that the common performance of the governments of the countries within the framework of the project was "satisfactory" and that the assumption of national responsibilities for the management of the GAS in each country, as opposed to the regional level, could be described as "very satisfactory" wherein the sustainability of the monitoring network, the efficient functioning of SISAG, and maintenance of pilot projects in border areas of critical risk were assumed by the countries involved. Although the CSPD assumed responsibility and interest in the protective management of the GAS and was approved the SAP, it did not make the decisions necessary for sustainability of the project's achievements at the regional scale in a timely manner.

Annex 8. Comments of Cofinanciers and Other Partners/Stakeholders

Hannover, July 10th, 2009

The World Bank

Attn.:

Mr. Douglas C. OLSON
Lead Water Resources Specialist

Mr. Samuel Taffesse
Operations Officer

Environmentally and Socially Sustainable Development,
Latin America and the Caribbean Region

Subject: Guarani Project: Implementation Completion and Result Report (ICR)

Ref.: Your E-mail dated July 07th, 2009

Dear Gentlemen,

your report reflects clearly the activities and the progress achieved by the Guaraní Project.

Keeping in mind that such an ambitious project with the special regional character can be considered as a challenge, it can be stated that the execution level of the project is excellent, achieving the results and indicators previewed.

In addition to my remarks on the draft version (I sent them to you by E-mail on Monday, July 06th, 2009) there are no further comments of major importance on the ICR from my side.

Please, allow me to illustrate with some words the background and the role of the BGR project SAG-PY and its multiple functions.

The BGR participation in the Guaraní-Project cooperating agency has been suggested and arranged during the preparation phase with The World Bank, OAS and SEAM (Paraguay) (see agreed meeting minutes, Washington, May 21, 2002). The area in the triangle Encarnación - Ciudad del Este - Caaguazú has finally been declared as the "hot spot" in Paraguay for the development of regionally-appropriate groundwater management. Later on, the activities have been extended to the whole oriental region of Paraguay.

BGR has been commissioned by the BMZ (Federal Ministry for Economic Cooperation and Development) to run the project SAG-PY "Sustainable Use of the Transboundary Ground-water Resources of the Guaraní Aquifer System in Paraguay" as part of the Technical Cooperation Project (BMZ Project No. 1994.2029.0) which provides funds for assistance and cooperation in order to cover know-how deficits in the geo-sector.

The SAG-PY project was planned to enhance the knowledge about the Guaraní Aquifer System in Paraguay, including also results from the Guaraní Project at a later stage. In addition, results and products from SAG-PY were foreseen to be incorporated into the Guaraní Project as Paraguay's national contribution.

The SAG-PY project activities started in Asunción in May 2003, a few days after launching the Guaraní Project in Montevideo. In November 2003 the BMZ agreed to prolong the duration of the SAP-PY project by one year (from 3 to 4 years) in correspondence with the current SAG-GEF project phase ending in 2007. After a further synchronization with the schedule of the Guaraní Project, SAG-PY has been completed in February 2009.

Let us hope that the spirit of cooperation and mutual understanding between the countries and all partners will continue during the future transboundary aquifer resources management, recognising the experiences from the Guaraní Project,

Yours sincerely,

Gerhard Schmidt
Senior Geohydrologist
Sub-Department 2.3
Groundwater Resources - Quality and Dynamics

Annex 9. List of Supporting Documents

Manganelli, Alberto. 2009. Síntesis Hidrogeológica del Sistema Acuífero Guaraní. (Borrador).

GEF. International Waters. http://www.thegef.org/interior_right.aspx?id=236.

Independent Evaluation Group (IEG).. 2006. "Guarani Aquifer Project: An Independent Evaluation of the World Bank's Support of Regional Programs." Unpublished.

Project documents:

- Estudio de la Dinámica del Agua Subterránea en el Sistema Acuífero Guaraní (SAG) Mediante Técnicas Isotópicas. Agosto, 2008.
- Evaluation of potential of thermal and non-thermal uses of GAS water, Consorcio Guarani, 2008.
- Evaluación sociodemográfica de la capacidad de adaptación a cambios de los usos del Sistema Acuífero Guaraní. Agosto, 2007.
- Mission Aide Memoires.
- Servicios de Hidrogeología General, Termalismo y Modelo Regional del Acuífero Guaraní:
- Transboundary Diagnostic Analysis
- Strategic Action Plan. 2009.
- Project Appraisal Document. 2002. Report No. 23490-LAC.
- Project website: http://www.sg-guarani.org/

The World Bank. 2000. Argentina: Country Assistance Strategy. Report # 20345-AR.

____..2000. Brazil: Country Assistance Strategy. Report # 20160-BR.

____.. 2000. Uruguay: Country Assistance Strategy. Report # 20355-UR.

____. 2003. Paraguay: Country Assistance Strategy. November 2003. Report # 27341-PA.

____.. 2005. Uruguay: Country Assistance Strategy. May 2005. Report # 31804-UY.

____.. 2006. Argentina Country Assistance Strategy. May 4, 2006. Report No. 34015-AR.

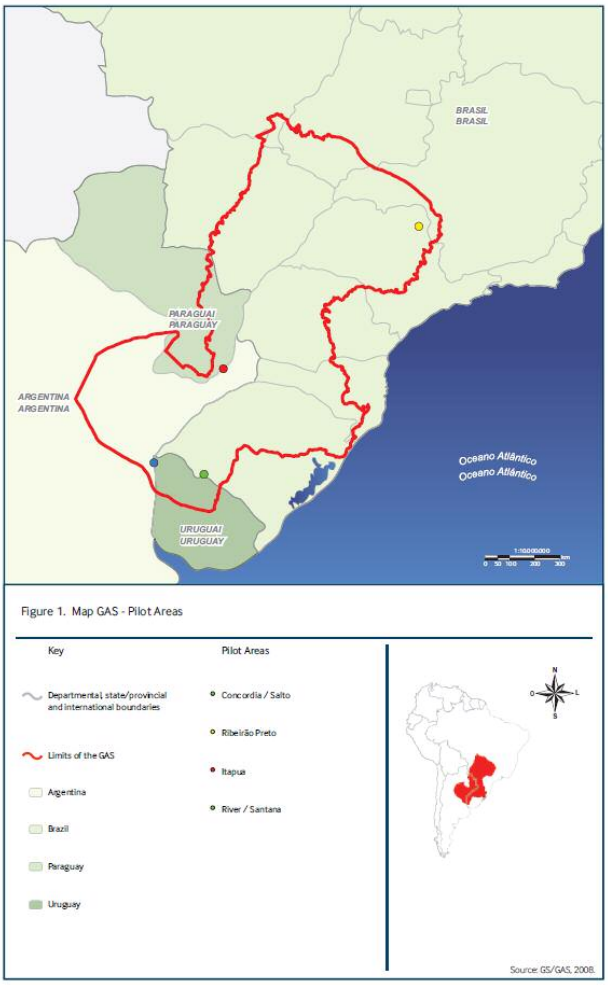
____.. 2007. Paraguay: Country Assistance Strategy. Report # 16346-PA.

____.. 2008. Brazil: Country Partnership Strategy. Report No. 42677-BR.

____. 2009. Argentina: Country Partnership Strategy. Report # 48476-AR

____. 2009. Paraguay. Country Partnership Strategy. Report # 48087-PY.

Map 1:
Geographical extension of the Guarani Aquifer System



Map 2:
Use of Guarani water by different sectors in the four countries

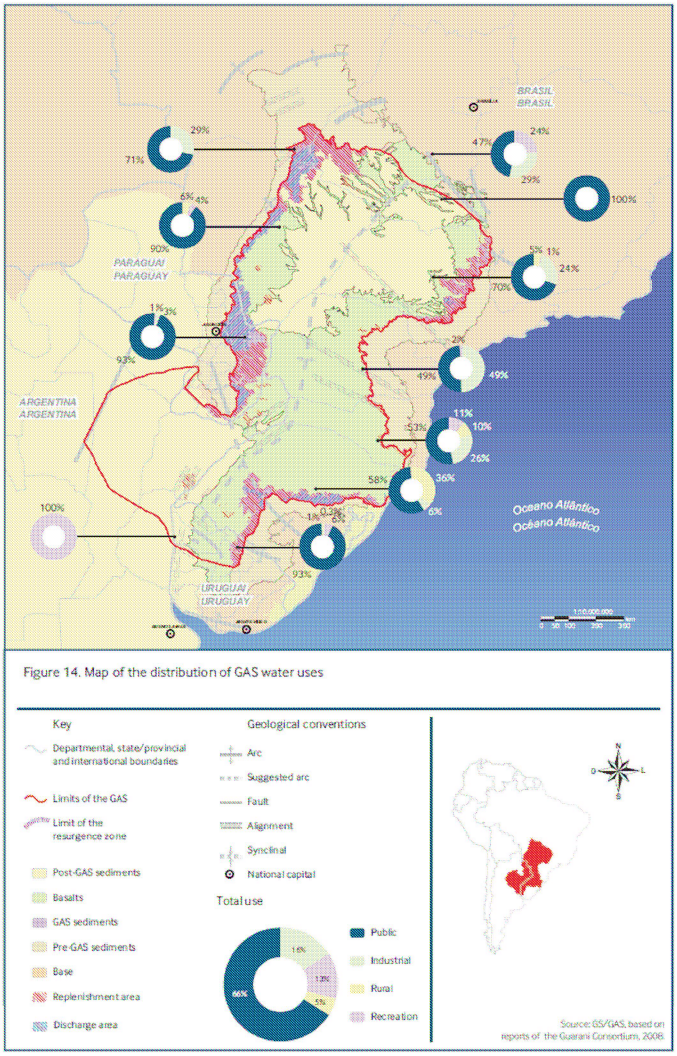


Figure 14. Map of the distribution of GAS water uses

Map 3:
Classification of GAS – Outcropping, semi-confined and highly confined regions

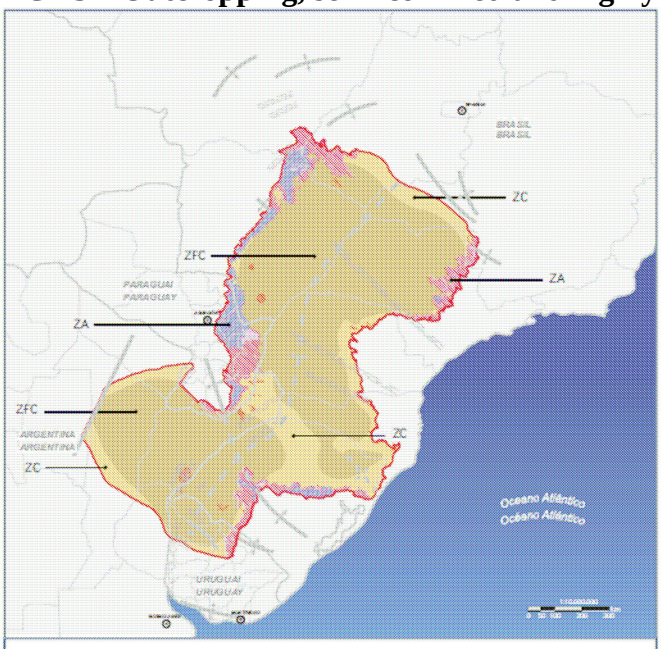


Figure 20. Proposes bases for zoning

Key

- Departmental, state/provincial and international boundaries
- Limits of the GAS
- ZFC Zone confined / strongly confined
- ZC Transition Zone / confined
- ZA GAS outcrop zone
- RA Replenishment area
- DA Discharge area
- National capital

Geological conventions

- Arc
- Suggested arc
- Fault
- Alignment
- Synclinal

Source GS/GAS. Adapted from GW-Mate and Guarani Consortium, 2008.

Map 4:
Distribution and Location of wells selected for GAS Monitoring Network

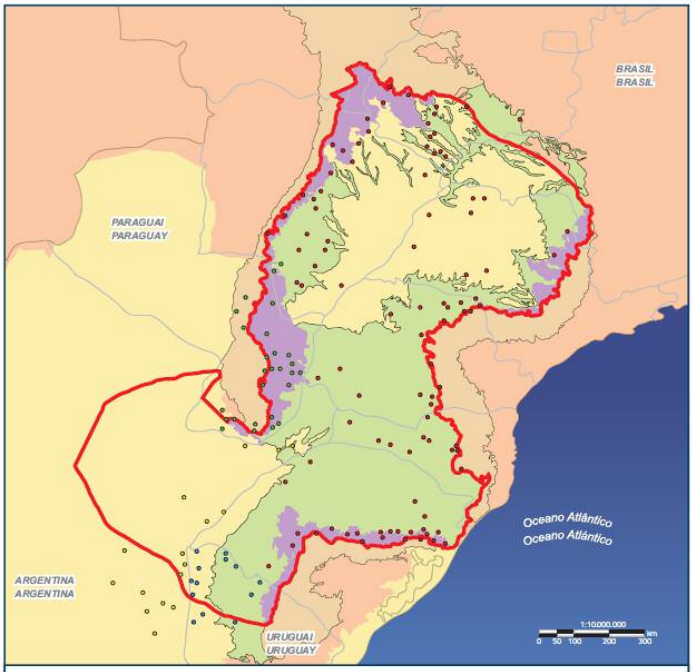


Figure 1. Location of selected wells

Key

- Departmental, state/provincial and international boundaries
- Limits of the GAS
- Post-GAS sediments
- Basalts
- GAS sediments
- Pre-GAS sediments
- Base

Abstract

- Argentina
- Brazil
- Paraguay
- Uruguay

Source: GS/GAS - Adapted from the Report on the Regional Monitoring Network, Guarani Consortium, 2008.

AFTER APPROVAL BY COUNTRY DIRECTOR

AN ORIGINAL MAP OBTAINED FROM GSD MAP DESIGN UNIT

SHOULD BE INSERTED

MANUALLY IN HARD COPY

BEFORE SENDING A FINAL ICR TO THE PRINT SHOP.

NOTE: To obtain a map, please contact

the GSD Map Design Unit (Ext. 31482)

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