

# GUARANI AQUIFER SYSTEM

## *Environmental Protection and Sustainable Development of the Guarani Aquifer System*

### ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT OF THE GUARANI AQUIFER SYSTEM PROJECT



**COUNTRIES:** Argentina, Brazil, Paraguay and Uruguay  
**IMPLEMENTING AGENCY:** The World Bank  
**REGIONAL EXECUTING AGENCY:** Organization of American States/Office for Sustainable Development and Environment (OAS/OSDE)  
**DURATION:** 2003-2007  
**WEBSITE:** <http://www.sg-guarani.org>  
**GEF GRANT:** 13.4 US\$ millions  
**CO-FINANCING:** 12.1 US\$ millions (countries' counterparts)  
**CO-FINANCING:** 1.2 US\$ millions (other donor agencies)  
**PROJECT COST:** 26.7 US\$ millions

*Schematic map of Guarani Aquifer System*

### INTRODUCTION

The Guarani Aquifer System (GAS) is a groundwater reservoir. The water is found in the pores and fissures of sandstones, formed during the geological times of the Mesozoic (ages between 200 e 130 million years ago), which are typically covered by thick layers of basalts that confined them.

The GAS constitutes one of the largest reservoirs of groundwater in the world, with current water storage of approximately 37.000 km<sup>3</sup> and a natural recharge of 166 km<sup>3</sup> per year. The water in the sandstones can be found at depths between 50 m to 1500 m, with temperatures that vary between 33°C and 65°C. This broad thermal range offers possibilities for diverse geothermic applications.

The GAS is located in the eastern and mid-southern South America and underlies in some areas of Argentina, Brazil, Paraguay and Uruguay. It is estimated that the total surface of

the GAS is 1.190.000 km<sup>2</sup> with 225.000 km<sup>2</sup> in Argentina, 850.000 km<sup>2</sup> in Brazil, 70.000 km<sup>2</sup> in Paraguay and 45.000 km<sup>2</sup> in Uruguay.

Approximately 24 million people live in the area delimited by the boundaries of the aquifer and a total of 70 million people live in areas that directly or indirectly influenced it. The main use of the aquifer is for drinking water supply, but there are also industrial, agricultural irrigation and thermal tourism uses.

### THE PROJECT

The Environmental Protection and Sustainable Development of the Guarani Aquifer System Project was developed to support Argentina, Brazil, Paraguay and Uruguay to elaborate and implement a shared institutional, legal and technical framework to preserve and manage the GAS for the current and future generations. The General Secretariat of the Project will execute the project components between 2003 and 2007

in closed coordination with the four National Executing Agencies. The development of the Project was made possible thanks to the harmonious cooperation among Argentina, Brazil, Paraguay and Uruguay, the countries in which the GAS is located, and with the collaboration of the Global Environment Facility (GEF), the World Bank (WB), the Organization of the American States (OAS), the Netherlands and German Governments and the International Atomic Energy Agency.

The long term objective of this Project is the sustainable management and use of the GAS in Argentina, Brazil, Paraguay and Uruguay, through an adequate and functional management framework, based on appropriate technical, scientific, institutional, legal, economical and environmental guidance. The objectives of the Project are:

- To enhance and enlarge a technical knowledge of the Guarani Aquifer System.
- To implement a permanent Well Monitoring Network and an Information System for the whole GAS.
- To elaborate the Strategic Action Plan (SAP) and the Transboundary Diagnostic Analysis (TDA).
- To develop a proposal for a coordinated management framework, harmonizing water policies and management tools among the four participating countries, reducing future qualitative and quantitative threats to the GAS.

The Project is organized in seven interrelated “components”, which are designed to aid in a better understanding of the morphology and behavior of the GAS, its use and conservation, and its relationship with communities and institutions. This knowledge will inform the development of systems and tools for coordinated management of the waters in the GAS. Specific components of the GAS project are:

### **COMPONENT 1 — Expansion and Consolidation of the Current Scientific and Technical Knowledge Base of the Guarani Aquifer System.**

The objectives of this component are to analyze, synthesize and expand the existing base of scientific and technical knowledge of the GAS in the four countries. This information will assist in the development and implementation of a consensual and effective framework for the protection and sustainable development of the aquifer and to expand and improve the understanding of the potential of the GAS and threats to the quality and quantity of its waters. It is structured in two sub-components:

- 1 (a) Aquifer studies for consolidation and expansion of the scientific knowledge base, to quantify and disseminate scientific knowledge on the geometry, structure and

hydrodynamic behavior of the aquifer and to determine the southern and western boundaries of the GAS. These studies will include a thorough inventory of public and private wells, an investigation of the characteristics and magnitude of existing pollution of the GAS and identification of the areas of recharge (hydrogeology and dynamics).

- 1 (b) Technical and socio-economic assessment of current and future use scenarios of the Guarani Aquifer System to evaluate current and future uses of the aquifer. This assessment will identify interactions between these uses and available technologies for surveying, extracting and using aquifer waters.

### **COMPONENT 2 — Joint development and implementation of the Guarani Aquifer System Management Framework, based on an agreed Strategic Action Plan.**

It is considered to be the core of the project and it is informed by all the other components. The objective is to develop a coordinated management framework based on technical, institutional, economical and legal understanding of the GAS. This framework will take the principles of sustainable integrated development, potential use of the aquifer; it will be established within a Strategic Action Plan (SAP), which



*Guarani outcrop at Itapúa, Paraguay*

will articulate, in both space and time, the principal lines of action necessary for achieving the project’s long term objective. It is structured in five sub-components:

- 2 (a) Design and implementation of an aquifer monitoring network that provides results early in the execution phase. This network includes the systematic data gathering from 5% of all wells.
- 2 (b) Development and integration of an Information System that facilitates the management, standardization, dissemination and utilization of aquifer data. This system will provide the technical basis for decision making for the sustainable use of the aquifer.
- 2 (c) Formulation of a Strategic Action Program (SAP) that provides a strategic, coordinated management framework, which will facilitate and support solutions to the current and emerging problems of pollution and over-exploitation and other stresses that may threaten sustainable development of the aquifer.

- 2 (d) Institutional strengthening and capacity building to increase expertise within the region on groundwater management. Groundwater managers will be trained and a specific fund for research and capacity building for the universities of the GAS region will be established.
- 2 (e) Transboundary Diagnostic Analysis to define the primary root causes of stresses to be addressed in the border areas between the countries.

### **COMPONENT 3 — Promotion of public participation, social communication and environmental education.**

This component will promote, support and enrich the participation and involvement of the public and stakeholder communities by fostering environmental and water education, social communication, and dissemination of knowledge about the GAS and the project. The pilot projects under this component will be supported. A Regional Communications Plan that will contribute to sensitizing and educating people in the Guarani Aquifer System region will be designed and implemented. This plan will ensure that relevant stakeholders are involved in preparing and executing the SAP. (Stakeholders include water users, resource management institutions, water services providers in both rural and urban areas, NGOs, academics, the private sector and minority groups and others). There are three sub-components:

- 3 (a) Design and implementation of regional participation plans and development of a social communication manual for the project. These will be based on a review of the status of information dissemination, and of public participation in the region.
- 3 (b) Establishment of a Guarani Aquifer System Citizen's Fund, which supports the development of strategies and concrete actions for spurring and strengthening environmental education and participation of community-based NGOs.
- 3 (c) Creation and dissemination of instruments to increase awareness, interest and commitment among stakeholders, with particular emphasis on measures to involve children and youth.
- 3 (d) Indigenous Peoples Strategy to provide information for indigenous people about the project and the necessity of water quality protection of the aquifer. This strategy will be informed by preparatory studies, consultations and discussions with key indigenous actors.

### **COMPONENT 4 — Project Monitoring and evaluation, and dissemination of Projects Results.**

The objective of this Component is to create and implement a system for recording and analyzing progress achieved during the project implementation period. This system will allow early

detection of potential problems, and provide feedback to the plans on the experiences gained and lessons learned which under similar conditions and circumstances could be replicated in the GAS region.

- 4 (a) Development and implementation of a monitoring, evaluation system for the Guarani Project, based upon agreed management and performance indicators.
- 4 (b) Dissemination of Project results throughout the region and beyond through reports, Internet, international conferences, workshops and meetings, and direct exchange of different actors. The General Secretariat of the Project will act as a focal point for enabling interaction with other projects to facilitate information sharing and dissemination of Project approaches and results.



*Contact area between Botucatu formation and Serra Geral basalts at Torres, RS, Brazil.*

### **COMPONENT 5 — Development of groundwater management measures and mitigation measures within identified critical areas ("Hot Spots").**

It will design, apply and evaluate the costs and feasibility of good management practices at specific sites within the GAS region, establishing measures for the appropriate management and sustainable use of the aquifer.

The pilot projects will focus on the prevention of possible pollution sources and the over drafting of the aquifer in critical recharge and discharge areas or where there is a high concentration of uses and users.

It includes four pilot projects. Two of them are transboundary pilot projects related to current and emergent groundwater uses, the third is related to the development and understanding of the characteristics of the aquifer, and the fourth one deals with a heavily urbanized area:

- 5 (a) Concordia (Argentina) / Salto (Uruguay) will develop a better local understanding of the GAS behavior and will aid in the development of a local sustainable management plan of the thermal waters. In this manner it will also try to mitigate the transboundary problems related to the GAS groundwater exploitation for thermal tourism within a confined portion of the aquifer.

- 5 (b) Rivera (Uruguay) / Santana do Livramento (Brazil) was designed to assess mechanisms relating to the management and protection of subterranean waters within an unconfined portion of the aquifer. It will address concerns identified within geographic areas devoted to agricultural development, and those related to rural activities with relevant growth patterns. The elaboration of a joint management plan is also envisaged.
- 5 (c) Itapúa (Paraguay) has an approximate area of 800 square kilometers. Basalt spilling is found in half of this area, and out coming sandstone in the other half. There are samples of wells located in the chosen area, that show an incipient nitrate contamination. This pilot project is developed in an agricultural-farming region, being the soya the main plantation and the cattle the most representative livestock. Irrigation plans to intensify even more the agriculture exist. The pressures to change the soil use and the possible environmental impact of these activities, make it necessary to study the technical-economical feasibility to carry out a sustainable use of the territory, protecting the underlying Guarani Aquifer.
- 5 (d) Ribeirão Preto (Brazil) will review and update information about localized pollution and overdrafting of the aquifer in densely populated zones. It will also leverage current activities by the Government of Brazil and the State of Sao Paulo regarding groundwater protection and management measures in this region.

### **COMPONENT 6 — Assessment of geothermal energy potential use, “clean energy”, from the GAS**

This component’s objective is to evaluate the geothermal potential of the GAS in scientific, technical, economic, financial, and environmental terms, and to provide this evaluation to the participating countries. The waters are currently being exploited for thermal tourism primarily in Uruguay and, to a lesser degree, in Argentina and Brazil. Conditions for the development of thermal waters occurrences in tourism exist in Paraguay as well as in certain specific regions of the aquifer.



*Thermal complex at Salto, Uruguay*

It will also assess the possibility that these thermal waters could also be used in industrial processes, and for the generation of energy as a substitute for

fossil fuels, options that will have to be evaluated in technical, economic, social, and environmental terms.

### **COMPONENT 7 — Project Coordination and Management**

The objective of this component is to provide organizational and administrative support to the project. It includes activities associated with project leadership and coordination within the regional context, together with analytical capacity and production of specific material and documents.

The General Secretariat of the Project and the Coordination Group act as a focal point for the dissemination of project results, and for coordination with other Global Environmental Facility Projects, and for the development of specific actions in each country. The World Wide Web communication networks and other mass media communication mechanisms are utilized to facilitate this interaction.



[www.oas.org/osde](http://www.oas.org/osde)

This document has been prepared by the Office for Sustainable Development and Environment of the Organization of American States (through the General Secretariat of the Guarani Aquifer Project), as the regional executing agency for the Guarani Aquifer Project, in collaboration with the World Bank (implementing agency for the Global Environment Facility), and the Governments of Argentina, Brazil, Paraguay, and Uruguay. The document is intended to provide general information on the status, preliminary results and follow-up activities regarding project implementation, and do not necessarily reflect the opinion of the participating countries, the World Bank, the Organization of American States, or the GEF.