

# Sustainable Groundwater Management Lessons from Practice

Case Profile Collection Number 3

## Actual and Potential Regulatory Issues Relating to Groundwater Use in Gran Asunción, Paraguay

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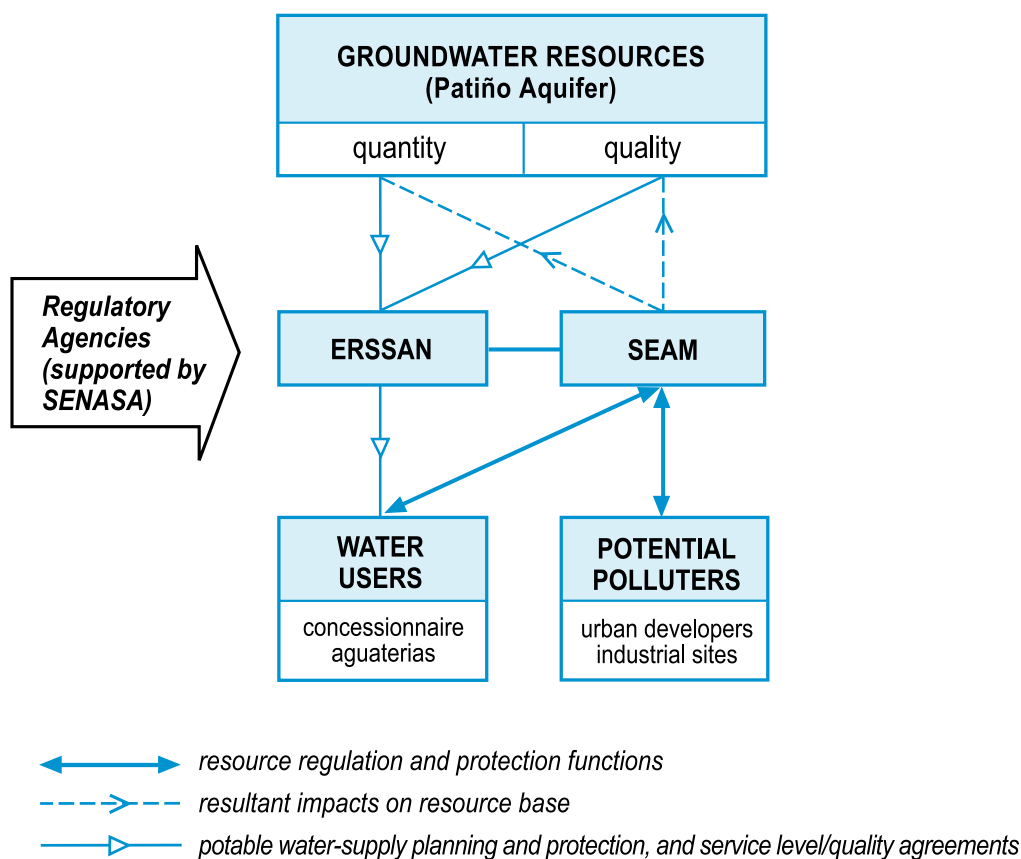
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*The purpose of this GW•MATE consultancy was to undertake a diagnosis of groundwater conditions, use and status in Gran Asunción and to identify issues that could influence overall water-sector policy and that need intervention by the newly-constituted regulator ERSSAN (together with other national institutions and/or the proposed new urban water-services concessionaire). The data on which the diagnosis is based was provided mainly in the form of unpublished reports by ERSSAN, Corporación Nacional de Obras Sanitarias (CORPOSANA) and most especially by Servicio Nacional de Saneamiento Ambiental (SENASA) and the Netherlands Geological Survey (TNO-NITG), but are not cited in detail here.*

### Water Sector Institutional Arrangements

- Paraguay is undergoing a period of rapid institutional transformation in the water sector. This has included the creation of two new regulatory organisations — ERSSAN and SEAM (Secretaría del Ambiente) — which are not yet staffed to perform the operational functions (water service regulation and resource/environmental management) respectively assigned to them. Moreover, the limits of competence of, and interface between, the two organisations has still to be precisely defined, but could be as depicted in Figure 1.
- Various issues need to be resolved through the refinement, authorisation and implementation of a new water law, which is still being debated. However, it is preferable not simply to ‘force through’ the approval of this law and better to learn from experiences (like those described here) to define exactly which powers are required and which provisions are enforceable, and in this way develop a legal framework which is well focussed and capable of being implemented.
- In the interim at least, and perhaps in the long-term, it will be essential (especially on groundwater and water quality issues) for ERSSAN to draw upon the established expertise of SENASA to perform adequately some of its key functions, including those identified below. Another need is the establishment of some form of ‘water resources management group’ for Gran Asunción, in which the above organizations, plus the various water user and environmental interest groups, are represented.

**Figure 1: Summary of general institutional scheme of proposed groundwater resource administration in Paraguay**

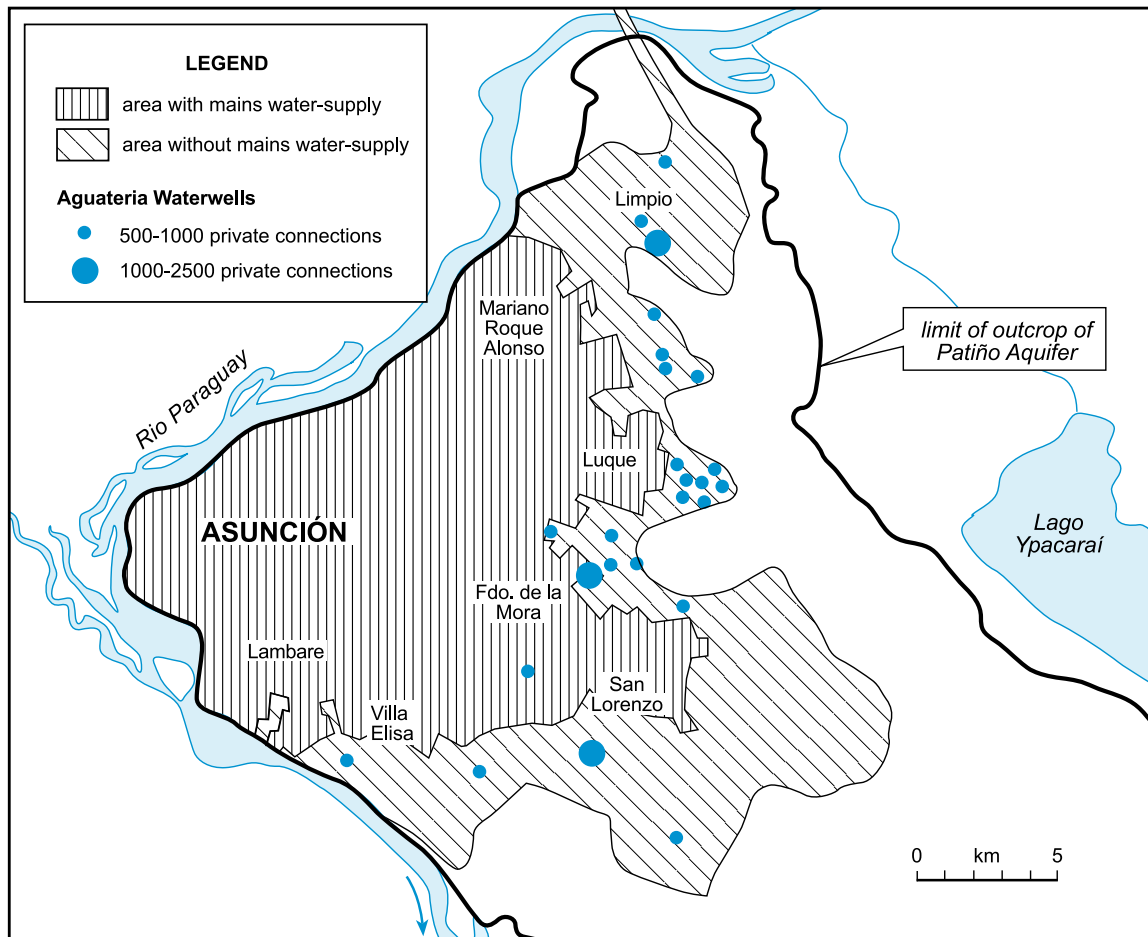


### Current Status of Water-Supply Provision

- The level of current exploitation and dependence on groundwater resources in Gran Asunción is almost certainly much greater than is commonly assumed. In reality abstractors fall into four categories:
  - the existing autonomous water-service utility (CORPOSANA), who since the 1980s have operated some 10-18 large-diameter production boreholes of 150-250m depth to provide more reliable mains water-supply and pressure at the ‘ends’ of their distribution network
  - as many as 300 ‘Aguaterias’, who started to appear from the 1970s to provide reticulated water-supplies locally from small-diameter boreholes of 80-120m depth in systems with usually 100-600 connections, especially in the Municipalities of San Lorenzo, Lambare and Luque (Figure 2)
  - individual commercial abstractors (industrial premises, residential condominiums, bottled drinks enterprises, etc), who operate similar boreholes to the ‘aguateros’
  - domestic dugwells (pozos artesanales) up to about 20m depth, with simple manual or mechanical pumps, which have been constructed in many periurban dwellings.

- There are no reliable measurements/records of the amount of groundwater being abstracted, but various approaches were adopted to give a preliminary idea:
  - estimates for the CORPOSANA boreholes, based on the number pumping continuously and average pump capacities, generate a total average pumping rate of 19-23 MI/d; although statistics in a recent financial analysis give a potential for pumping of 270 l/s (23 Mm<sup>3</sup>/a) but an actual abstraction of only 45 l/s (4 Mm<sup>3</sup>/a)
  - estimates of abstraction by the 'Aguaterias' suggest that they supply some 28% (around 371,000) of the population and, taking 150-250 l/d/cap for water-supply in these areas, this probably amounts to 56-74 MI/d
  - a detailed survey of a pilot sub-catchment (in San Lorenzo and Nemby Municipalities) estimated abstraction at 36 MI/d (428 l/s) and 5 times more pumping wells were identified than in the SENASA non-statutory records.
- It would thus appear possible (or even likely) that the total current rate of groundwater abstraction is in excess of 100 MI/d (36 Mm<sup>3</sup>/a, if continuous throughout the year), compared to the current production of about 300 MI/d from the CORPOSANA treatment plant on the Rio Paraguay. Evidently the water regulator will need to take an integrated view of urban water-supply situation rather than a narrow view of CORPOSANA (or its future concessionaire) in isolation.

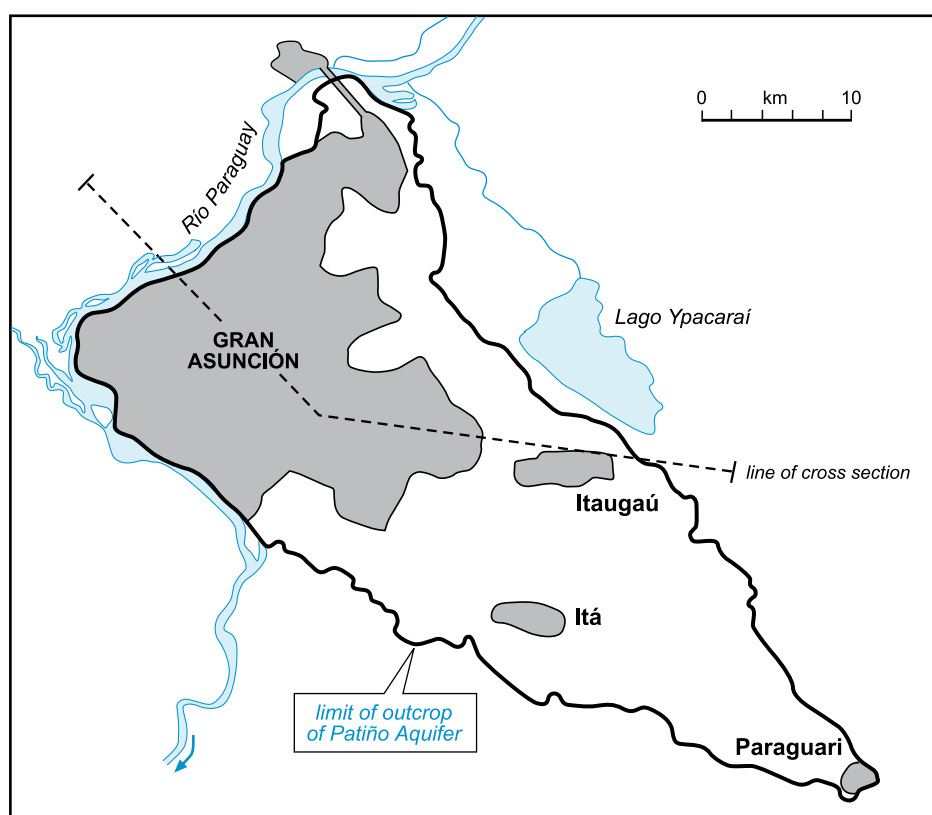
Figure 2: Map summarizing current water-supply arrangements in Gran Asunción



### Availability of Groundwater Resources

- Gran Asunción is directly underlain by an excellent groundwater reservoir — the Patiño Aquifer. This aquifer comprises a sequence of more than 300 m of aeolian and fluvial (medium-grained and weakly-cemented) Cretaceous sands, deposited in a NW-SE trending graben some 20-30 km wide (Figure 3). It provides very large groundwater storage and moderate well productivity, although hydraulic continuity may be locally impeded by volcanic intrusions. The location of the Patiño Aquifer, in an area with a population of about 2 million, its substantial annual recharge rates and very large groundwater storage mean that it must be regarded as a key strategic reserve, which merits effective management and protection.
- The aquifer is regularly recharged across its outcrop of some 1170 km<sup>2</sup> by excess rainfall in the range 300-400 mm/a. The situation in the urbanized areas (around 30% of the aquifer outcrop) is more difficult to assess, but recharge rates in excess of 500 mm/a have been reported. Here surface impermeabilization will increase losses of high-intensity rainfall by surface runoff, but this is likely to be more than balanced by increased aquifer recharge from leaking water mains and in-situ sanitation ('pozos ciegos'), only 33% of the population currently being served by mains sewerage. Most estimates of current total average groundwater replenishment put it well in excess of 500 Mm<sup>3</sup>/a (1370 Ml/d).

Figure 3: Location of Gran Asunción with respect to the outcrop and recharge of the Patiño Aquifer



- Until recently there were no aquifer water-level data to determine seasonal water- groundwater abstraction. A network of 10 observation boreholes has been recently installed by SENASA in the San Lorenzo-Nemby area, but it is too early to draw any conclusions on the response of the aquifer system to the relatively high rate of abstraction in this area.

### Threats to Groundwater Supply Quality

- Along the Río Paraguay flood plain (and westwards into the Chaco), the Patiño Aquifer contains brackish water at relatively shallow depth, which may extend at greater depth below Gran Asunción (Figure 4). If boreholes are drilled too deep and/or pumped too hard they are liable to produce increasingly saline groundwater.
- The Patiño Aquifer is generally of moderate (and locally, where the water-table is shallow, high) vulnerability to groundwater pollution. A recent survey of the types of human activity capable of generating a significant subsurface contaminant load in the San Lorenzo-Nemby pilot study area suggest that the main threats are posed by in-situ sanitation in densely-populated areas, tanneries, gasoline-filling stations, automobile and metal workshops. Agricultural cultivation on the well-drained acidic soils may experience some leaching of nutrients and pesticide compounds.
- The Patiño Aquifer would not be expected to experience severe pollution by microbiological contaminants or aromatic hydrocarbons, but it could be vulnerable to pollution by more persistent chemicals (such as nitrates, certain synthetic chlorinated organics). A recent survey, however, also suggested that 70% of the production wells sampled have fecal coliform contamination, some with elevated counts mainly in areas with in-situ sanitation. Field and laboratory protocols first need to be verified, but if confirmed it would be suspected that inadequate well construction and inappropriate sanitation practices result in 'short circuits' leading to fecal coliforms penetrating to greater depth than normal for this type of aquifer.

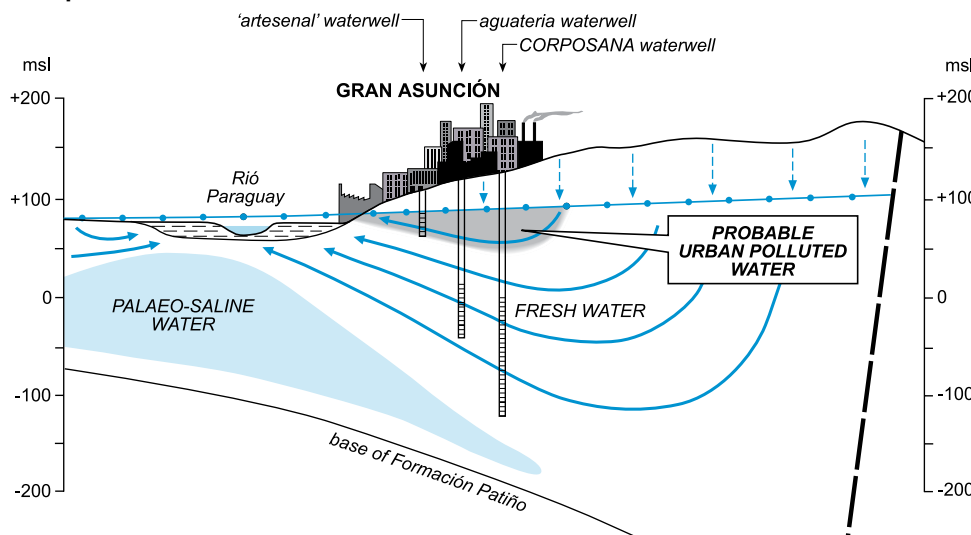
### Vision of Future Groundwater-Related Scenarios

- In evaluating requirements for effective regulation of water-supply and sanitation in Gran Asunción, the above situation carefully into consideration. Moreover, the following potential future scenarios need to be planned for:
  - the CORPOSANA concessionaire opting for the development of groundwater resources as the least-cost option for meeting demand in the main growth areas distant from the Río Paraguay
  - an 'explosion' of private well drilling in response to rising average water tariffs (related to the need for more extensive mains sewerage coverage), there being no control on groundwater abstraction beyond a little-enforced local regulation for payment of a 'municipality fee' for commercial use
  - rapid expansion of groundwater production capacity in response to a possible or actual loss of the surface water intake on the Río Paraguay (due to extended drought, unexpected pollution or other factors) by the CORPOSANA concessionaire
  - possible rising groundwater table effects in the lowest-lying districts, if groundwater use reduced and surface water imports increased for some reason, accompanied by failure to reduce water mains leakage and/or to extend mains sewerage coverage.

### Integrated Action on Groundwater Resource Regulation

- In view of the existing, and potential future, importance of groundwater in the overall water-supply of Gran Asunción, it is strongly recommended that a programme to integrate groundwater resources into urban water-supply and sanitation regulation is a priority action to be promoted by ERSSAN, in cooperation with other national institutions.

**Figure 4: Schematic hydrogeological cross of Gran Asunción showing groundwater flow regime in Patiño Aquifer**



- This would need to include the following interrelated actions, which could be implemented as semi-independent projects:
  - extension to full coverage of recent SENASA pilot surveys of groundwater use and quality, aquifer vulnerability, potential pollution sources and protection requirements, and installation of an aquifer monitoring network
  - implementation (with SENASA) of a groundwater resource study with aquifer numerical modelling of possible development and management scenarios, including the feasibility of increased groundwater use by the CORPOSANA concessionaire and its potential effects on wetlands
  - assessment of the priorities for construction of mains sewerage based on parameters related to groundwater — vulnerability of underlying aquifers to pollution, density of population in the urban district concerned, potential sanitation problems related to shallow groundwater table, etc
  - promotion of a ‘national pilot’ project for the systematic registration of waterwell drilling and control of groundwater abstraction and use rights for the Patiño Aquifer.
  
- In addition the following also need to be promoted:
  - vigilation of the chemical and microbiological quality of the groundwater sources of the CORPOSANA concessionaire, all of the ‘Aguaterias’ and larger individual private users, and improvement in existing well protection
  - a publicity campaign on the potential hazards of water-supplies from ‘pozos artesanales’ for some domestic uses without boiling, and the need for greater caution in siting, design, construction and operation of ‘pozos ciegos’ on residential premises.

**Publication Arrangements**

The GW•MATE Case Profile Collection is published by the World Bank, Washington D.C., USA. It is also available in electronic form on the World Bank water resources website ([www.worldbank.org/gwmate](http://www.worldbank.org/gwmate)) and the Global Water Partnership website ([www.gwpforum.org](http://www.gwpforum.org)).

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