**Transboundary Aquifer Yrenda – Toba – Tarijeño (Argentina, Bolivia, Paraguay. South America): ground water- surface water relations.**

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## ABSTRACT

This paper presents the results of the activities carried out for the hydrogeological assessment and subsequent mathematical modelling of the groundwater flow in the Yrendá – Toba – Tarijeño transboundary aquifer system, located beneath the alluvial fan of the Pilcomayo River between Ibibobo and Misión La Paz – Pozo Hondo (Argentina, Bolivia and Paraguay). The aquifer system has an area of about 250.000 - 300.000 km2, fact which should be corroborated, since its limits should still be verified.

In the Republic of Bolivia it embraces the Departments of Tarija, Chuquisaca and Santa Cruz de la Sierra, and it is associated with the alluvial cones of the large rivers of the Chaqueña plain. In Paraguay it is considered included into the great region of the Chaco and in Argentina underlies several provinces at the north-west portion of the country.

The amount of people that could benefit from the utilization of this aquifer system is considered larger than 500.000 inhabitants.

Due to the great heterogeneity of the geological formations that contain the water, there is a wide spatial variability of its quality, from saline-brackish to sweet.

Until the 1990s, these three countries were yet to know they were in the presence of a transboundary aquifer.

In Bolivia the system has been defined as multilayer, with interconnected and interbeded levels among it. According to the behavior of the system it is possible to distinguish unconfined, confined and semiconfined layers. Water has acceptable salinity, around the 1500µS/cm of electric conductivity. The existent wells don't generally overcome a flow of 3 l/s.

In Paraguay, this complex of confined and semiconfined levels housed in silts of the Tertiary and Quaternary ages was designated as “YRenda” Aquifer (Y:place, Rendá: water, in Guaraní language). It´s occurrence has been defined towards the south of the line of 21° Latitude South in the American Great Chaco area. It is generally found in depths lower than 50 m in the West, decreasing to the East. The formations´ lithology is constituted by fine and medium sands, inserted with strata of loamy material, with levels of plaster and carbonatics concretions.

A great heterogeneity of water quality can be found in Argentina, as well as in the productivity levels of the different aquifer reservoirs of the system. It has been also defined as a multilayer system, constituted by an unconfined aquifer with uncertain number of deeper semiconfined and confined layers.

These alternated levels of salted-brackish and sweet water are yet to be properly identified and sized. Also, by estimations, it is considered that the main recharge of groundwater reservoirs is aloctonal, probably coming from the hydrological basins of the mountainous area located towards west of the Chaqueña plain.

In some sectors there have been already identified intensive exploitations, which are not efficiently controlled by the provincial states. This situation has generated important lowering of the piezometric levels. There is also risk of salinization for the aquifer levels of fresh water, due to constructive deficiencies of the wells.

According to the climatic characteristics of the area and the shortage of surface water resources, groundwater acquires an strategic interest in the socioeconomic development of the region.

So far, in the three countries, there are studies carried out at different scales, which define some aspects of the regional geology, hydrogeology and even the identification of the hidrochemical characteristics with the use of isotopic hydrology, but only in some sectors of the system. An integration of the existent information is necessary in order to identify the reservoir geometry and to establish the mechanisms of its operation.

The three countries have excellent vicinity relations and the antecedent of being included in the El Plata Basin. For that reason, they have agreements and treaties from last the century that assure the cooperation and the understanding in the shared administration of the superficial water resources. But as regards the topic of groundwater, there is no existence of antecedents of agreements, treaties or any other legal tool in validity.

Seeking the integration of the existing information, in 2007, Universities of Salta and El Litoral, from Argentina, elaborated the preliminary conceptual groundwater model. The stratigraphic sequence of hydrogeological interest (Tertiary and Quaternary geologic formations), jointly with the groundwater elevation map available from previous works, where taken into account. The potentiometric surface was quantified, hydraulic gradient, hydraulic parameters, and groundwater velocities and flows were estimated.

Using the analysis of both the geologic and hydrodynamic information, the preliminary conceptual groundwater model was defined considering that the system behaves hydraulically as a multiunit.

The construction of the mathematical model required a careful selection of data due to the scarce basic information available according to the study area and the purposes of the study. The calibration is well-considered because of the normalized root square error obtained (approximately 5%). In relation to this study, the groundwater flow was clearly defined and it was also possible to quantify the bidirectional relation between surface and groundwater, fact that was not taken into account up to that moment.

Continue working on these bases will be essential to generate the plans for regional development and appropriate legal tools for the utilization and sustainable management. As a result of that it will be possible to protect biodiversity, prevent desertification, and to identify and prevent the effects of the climatic change. All of this will be a genuine benefit to the inhabitatnts of this wide region.

**Key words:** transboundary aquifer, conceptual model, mathematical model

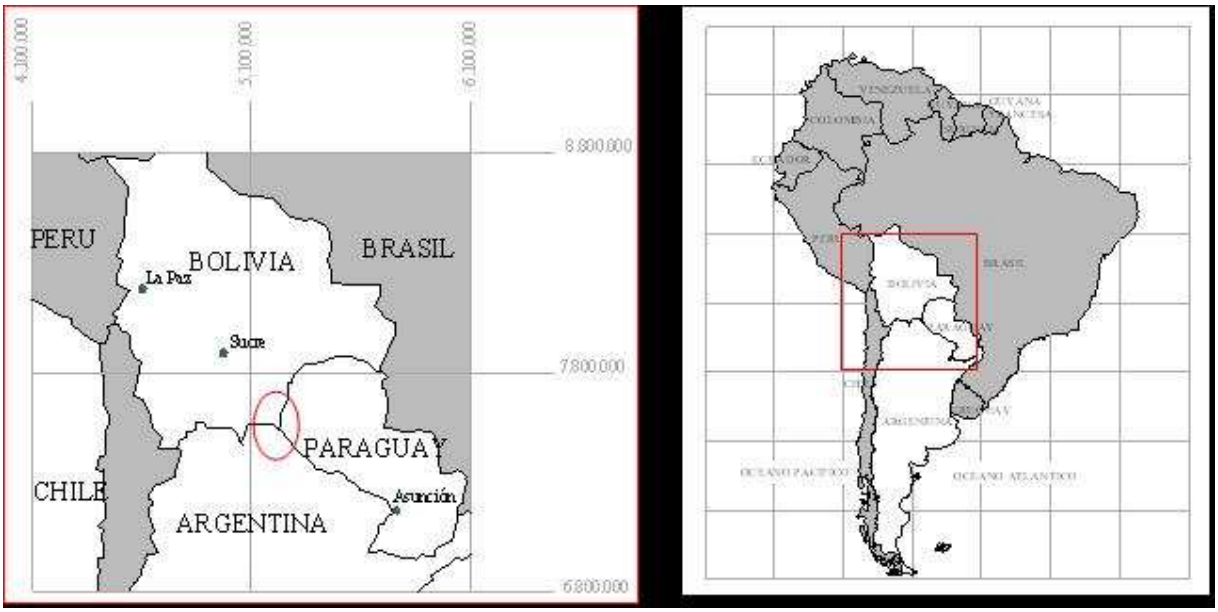


Figure 1: Location of the study area

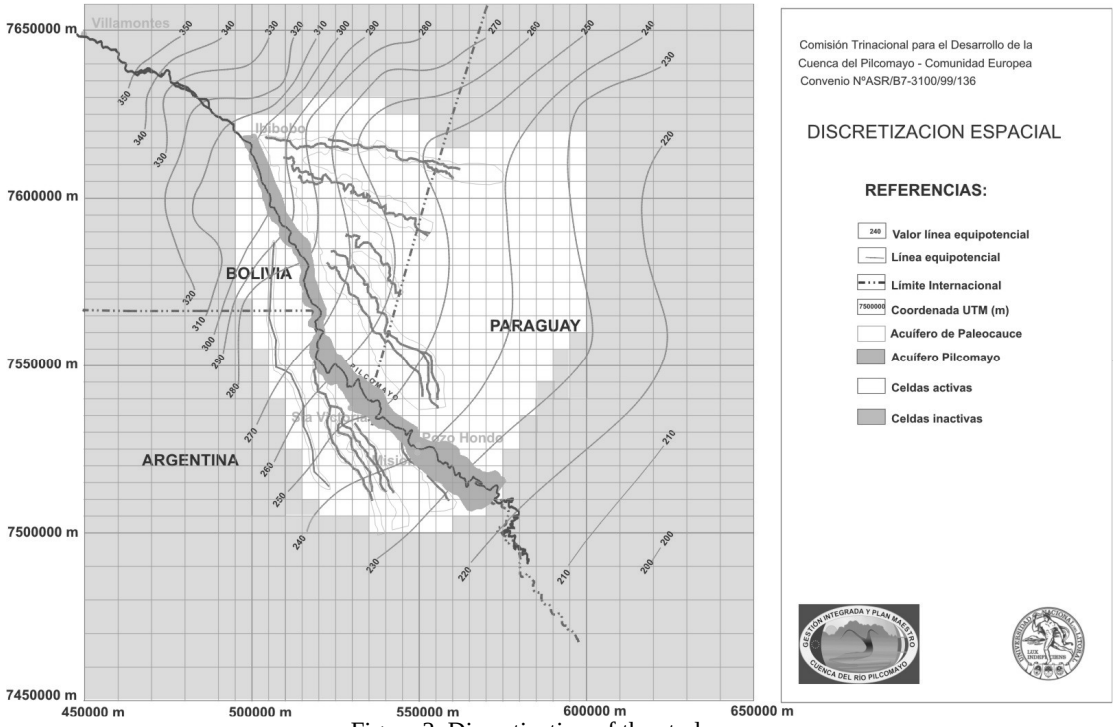

Figure 2: Discretization of the study area.