Integrated land and water management in the Yacambu-Quíbor Project, Venezuela

Hervé JEGAT and Luis MORA
CIDIAT – ULA
Centro Interamericano de Desarrollo e Investigación Ambiental y Territorial
Universidad de Los Andes
Apartado postal 219
Edificio CIDIAT Parque La Isla, Avenida Los Próceres
Mérida 5101 Venezuela
hjegat@gmail.com
Cell phone: +(58) 4147440575

ABSTRACT

The Yacambu watershed and the Quíbor valley are located in the western part of Venezuela, the first one south of the Andean Cordillera and the second one north of it. The Quíbor valley is an agricultural zone with a semi-arid climate, while the Yacambu watershed is a tropical humid forest. The valley possesses exceptionally favorable conditions for vegetable, fruit and livestock production of high quality and economic value, but while some 21,500 ha of the valley have potential for cultivation under irrigation only about 3,000 ha are currently in production. The design of the Yacambu-Quíbor water transfer scheme was initiated as long ago as 1973, with the object of supplementing Barquisimeto water supply and increasing the area of Quíbor valley under irrigation. It consists in building a dam on the Yacambu River to divert it to the Quíbor valley through a 25 km long tunnel. It will have a capacity to carry 330 Mm3 /year, of which about 30% was designated for urban water supply and the balance would be used to irrigate the 21,500 ha of agricultural land available. The basic elements of the project strategy are as follows:

• Reinforce the 'irrigation culture' of the Quíbor Valley, bearing in mind the existing land tenure jointly with other issues such as productivity, equity and infrastructure investment

• Explore irrigation distribution schemes that favor its efficient use but equitable access, recognizing the fact that water is the limiting factor in agricultural production

• Design an organizational structure that clearly separates the management of water resources from the provision of urban and irrigation water supply

• Establish water resource charges that, in addition to the recovery of costs, provide an incentive for users not to pump groundwater during certain periods to permit aquifer recuperation.

During the last 40 years a conservation program has been carried out in the Yacambu watershed to control agricultural soil losses and land erosion and therefore to minimize the sediment supply to the future reservoir. In order to achieve this objective, small control dams were built on several torrential creeks and reforestation was carried out in the upper watershed. At the same time an aggressive program to control and regulate the groundwater extraction in the Quíbor Valley was implemented as the aquifer has been depleted since the sixties.

Key words: Yacambu - Quibor project, Aquifer management, Sediment control

The Quibor Valley

The Quibor Valley in Lara State (Figure 1) constitutes an area of some 434 km2 with semi-arid climate and rainfall of 400-500 mm/a. It is situated 25 km south of Barquisimeto, a city of some 1.0 million population, which is the largest food distribution center in Venezuela. (Mora,2014)

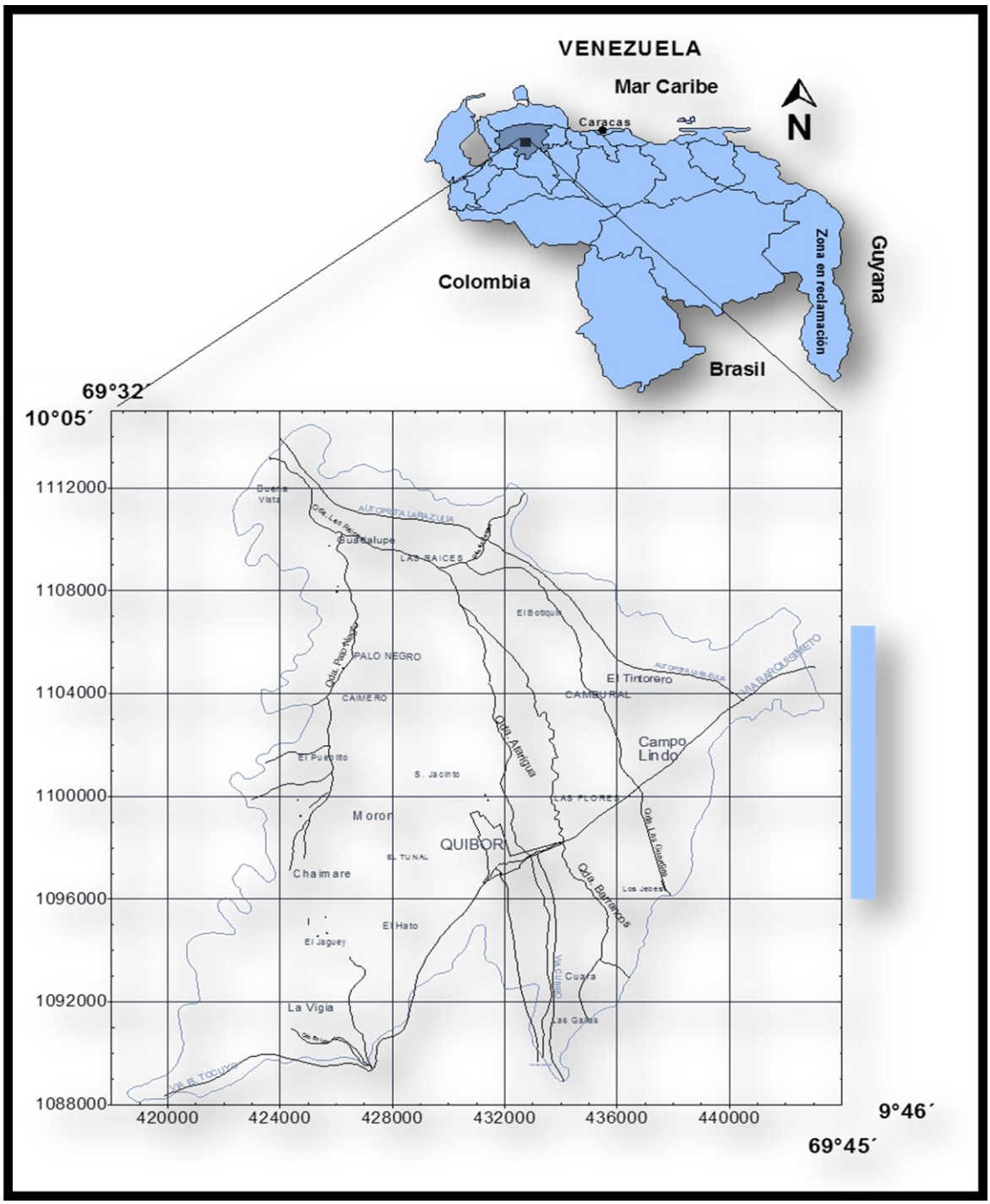

Figure 1. Yacambu – Quibor Project location

The valley possesses exceptionally favorable conditions for vegetable, fruit and livestock production of high quality and economic value, but while some 21,500 ha of the valley have potential for cultivation under irrigation only about 3,000 ha are currently in production.

Agricultural development in the Quibor Valley has been achieved through the exploitation of local groundwater resources, which occur in a Quaternary valley-fill comprising lenses of alluvial sand and gravel interbedded with lacustrine silts and clays. In the surface layers of the central valley floor clay strata predominate which restrict the rates of diffuse infiltration to groundwater. Nevertheless, it is estimated that the Quibor Valley Aquifer is recharged at an average rate of 22 Mm3 /a, mainly as a result of seepage from permeable streambeds at the margin of the main intermontane valley (Garduño, 2003).

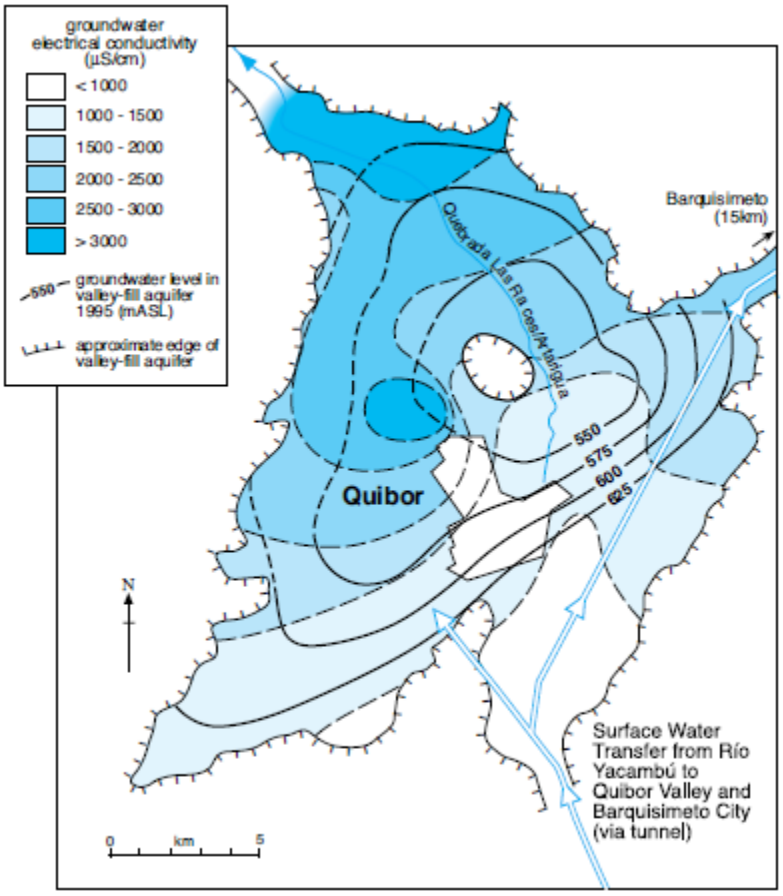

Figure 2. Hydrogeological sketch of the Quibor aquifer

The rate of groundwater abstraction for agricultural irrigation has exceeded the replenishment over a period of almost 40 years, and currently stands at around 25 Mm3 /a. This has led to a major reduction in the potentially exploitable aquifer reserves from some 350 Mm3 to 42 Mm^3, and in addition to continuously falling groundwater levels increasing groundwater salinity has also

been observed (Figure 2) – both of which threaten the productivity and profitability of local agriculture.

The existing water supply of the city of Barquisimeto is from wells in other local aquifers and from the Alto Tocuyo surface water system, but all of these sources (like those of the Quibor Valley) are proving insufficient to meet the increasing demand, both in the urban and agricultural sectors.

The Yacambu – Quibor Project

The design of the Yacambu-Quibor water transfer scheme was initiated as long ago as 1973, with the object of supplementing Barquisimeto water supply and increasing the area of Quibor Valley under irrigation. It has a capacity to carry 330 Mm3 /a, of which about 30% was designated for urban water supply and the balance would be used to irrigate the 21,000 ha of agricultural land available.

However, it is now predicted that for somewhere between 5 and 30 years there would be a potential excess of transfer water available, because (a) the full irrigation demand is unlikely to mature until 2011 and (b) Hidrolara (the Barquisimento water supply utility) would phase-out existing water supply sources gradually and thus would not take-up its full quota directly. This presents an opportunity for using excess transferred water, suspending current groundwater pumping for agricultural irrigation and allowing recuperation of the Quibor valley aquifer. A further consideration is that the Yacambu dam has 80% regulation capacity, which implies that under flood runoff conditions it should be able to generate an additional supply of 83 Mm3 /a part of which could also be used for artificial aquifer recharge.

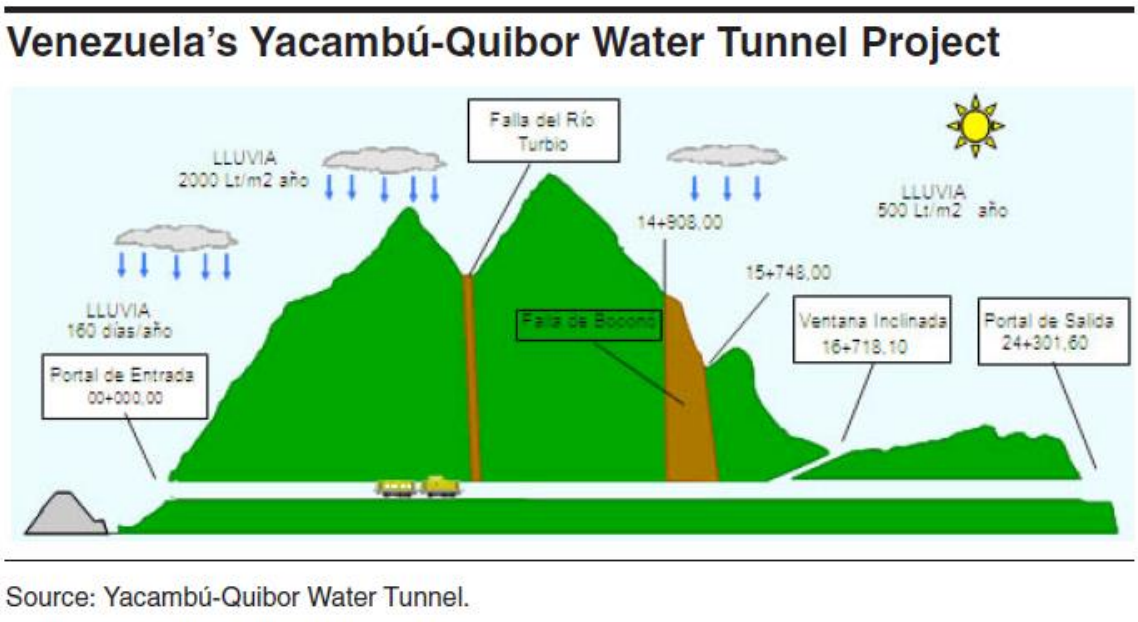

Figure 3. The Yacambu – Quibor project

The basic elements of the project strategy are as follows:

• Reinforce the 'irrigation culture' of the Quíbor Valley, bearing in mind the existing land tenure jointly with other issues such as productivity, equity and infrastructure investment

• Explore irrigation distribution schemes that favor its efficient use but equitable access, recognizing the fact that water is the limiting factor in agricultural production

• Align the role of state institutions as (a) promoter of irrigation system development (b) regulator ensuring that development of the natural resource base is sustainable (c) protector of agricultural areas against 'urban invasion' and 'environmental degradation'

• Design an organizational structure that clearly separates the management of water resources from the provision of urban and irrigation water supply

• Establish water resource charges that, in addition to the recovery of costs, provide an incentive for users not to pump groundwater during certain periods to permit aquifer recuperation.

Actual situation of the Quibor Valley

- About 50 % of the water used for irrigation comes from the aquifer
- The intensive use of groundwater for irrigation began in the 50´s (the first deep tube well was drilled in 1956).
- In 1995 the groundwater substraction reached 35 Mm^3 and the estimated natural recharge is about 23 Mm^3 /year.
- Currently there are about 70 active pumping wells and the static level declined more than 100 m during the last 40 years.

Social Organization and Land Tenure

The 'irrigation culture' of the Quibor Valley pre-dates spanish colonization. Since 1950, with the arrival of new immigrants from the Canary Islands, this culture has broadened to become 'water scarcity conscious', with the unreliable surface runoff being stored in lagoons of various sizes, the introduction of more water-efficient irrigation technology and improved water management at field level.

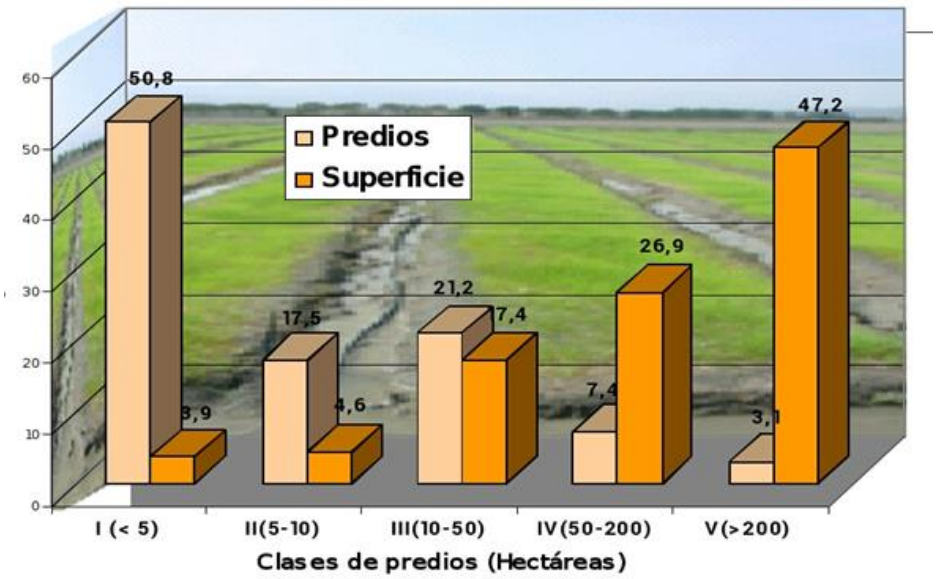

Figure 4. Land Tenure

Today there are 48 large-scale producers (with land holdings of more than 200 ha), 1,230 irrigators with medium-sized land holdings and a number of landless farmers who are cultivating fields of 5-20 ha on a cooperative or tenant basis (figure 4). In addition, there are some 3,000 agricultural laborers (representing 45% of the economically-active population of the valley) involved in land-based employment, whose socioeconomic position is especially precarious. An indication of the type of agricultural production involved is indicated from a 1988 study. A more recent survey shows that, while there is continuing interest in vegetables (especially onions), fodder grass is increasingly becoming a preferred crop. This pattern, with significant areas dedicated to relatively low-value and high-water consuming crops, is contributing to the aquifer stress.

Land and Water Governance in the Yacambu – Quibor Project

During the last 40 years a conservation program has been carried out in the Yacambu watershed to control agricultural soil losses and land erosion and therefore to minimize the sediment supply to the future reservoir.

In order to achieve this objective, small control dams were built on several torrential creeks and reforestation was carried out in the upper watershed. At the same time an aggressive program to control and regulate the groundwater extraction in the Quíbor Valley was implemented as the aquifer has been depleted since the sixties.

During the last 20 years, several studies have been carried out to improve our understanding of the aquifer in order to regulate and control the groundwater pumping in the valley.These studies were financed by the producers themselves. (CIDIAT-APROSELA, 2000)

In 2004 a zoning map was elaborated and accepted by the producers to implement the control of water substraction (figure5).

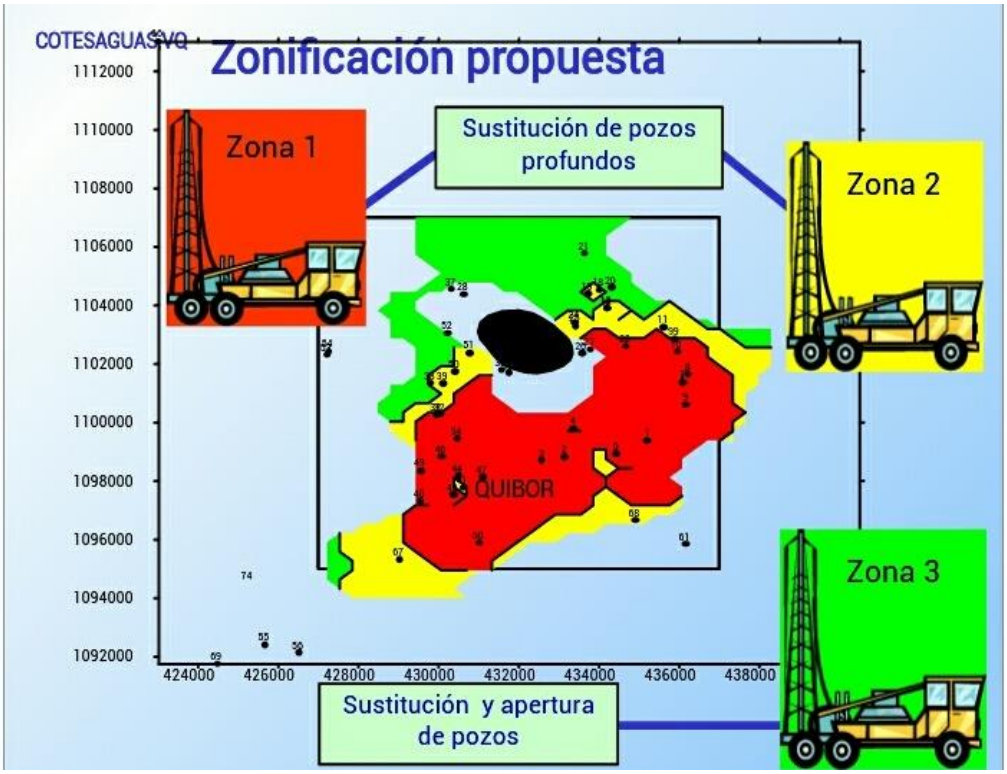

Figure 5. Zoning map of the Quibor Valley

The Sediment Problem

During the last 40 years a conservation program has been carried out in the Yacambu watershed to control agricultural soil losses and land erosion, and therefore to minimize the sediment supply to the future reservoir. In order to achieve this objective, small control dams were built on several torrential creeks and reforestation was carried out in the upper watershed. (CIDIAT-SHYQ, 2011)

There is a high potental risk of dam clogging on the mid term unless control and conservation measures are being implemented. The figure 6 shows the potential erosion rate in the Yacambu watershed.

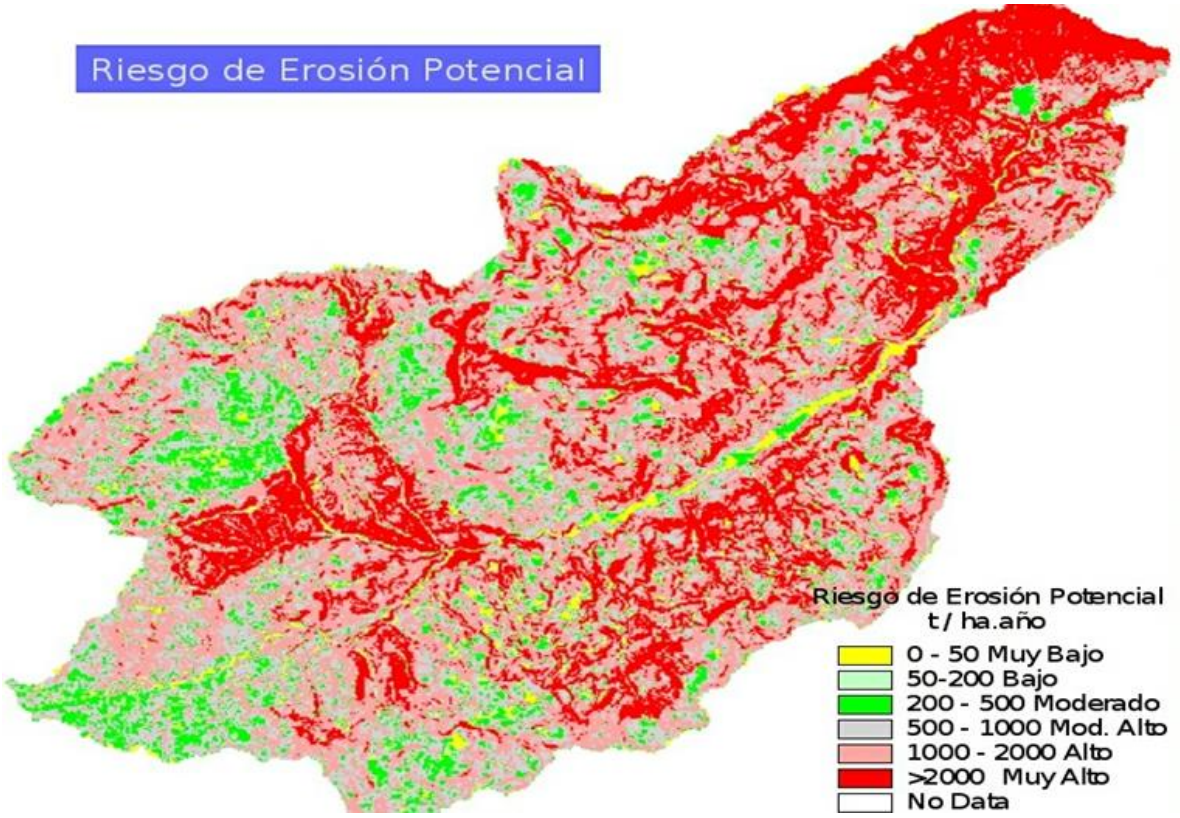

Figure 6. Potential erosion risk in the Yacambu watershed

Institutional and Legal Framework for Land and Water Management

The organization “Sistema Hidraulico Yacambu-Quibor (SHYQ)” was designated a public company in September 1989. The following strategies subsequently pursued by the company proved to be of great importance for the successful implementation of the water transfer project:

- adopting an inclusive posture with stakeholders and thus gaining community respect
- fostering a respectful relationship with agricultural producers of all scales to achieve consensus on the need for a sustainable approach to water resources

- using a participative approach to establishing the presence of the company within the population, as a basis for mounting effective campaigns for Yacambu catchment soil and water conservation for Quibor Aquifer groundwater management and quality protection.

The Yacambu-Quibor Project for the conjunctive use of surface water and groundwater resources has already become something of a model in its integrated approach at Venezuelan national level.

The National Constitution of 1999 modified the earlier 1961 provisions and designated all natural waters (both surface and underground) as of public domain, allowing the State to take necessary measures for their efficient management. In practice, however, water resource regulation still remains dispersed in a number of legal instruments, and recently a program for a new Water Law was approved by the National Assembly. Significantly, this is expected to incorporate a number of general recommendations which derive from the experience of the Yacambu-Quibor Project.

Challenges that still need to be addressed

Given uncertainty over the operational date for the water-transfer infrastructure, negotiation with users to reduce groundwater pumping is essential and urgent

A productive acceptable scheme to address the land tenure issues in the valley should be negotiated

Scheme for distribution of surface irrigation water should be established very soon to take full advantage of the new transfer water

Soil losses and erosion control programs should be negotiated with small producers in the Yacambu watershed

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