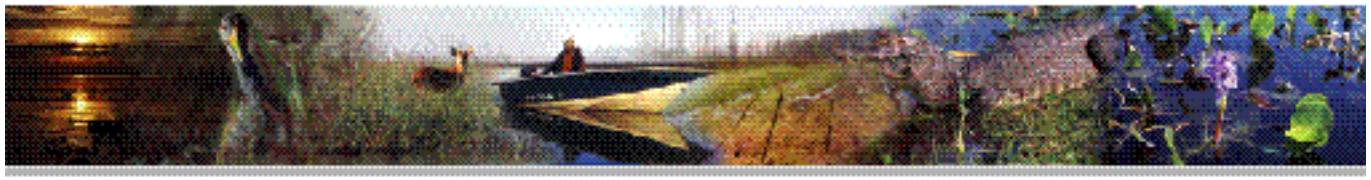
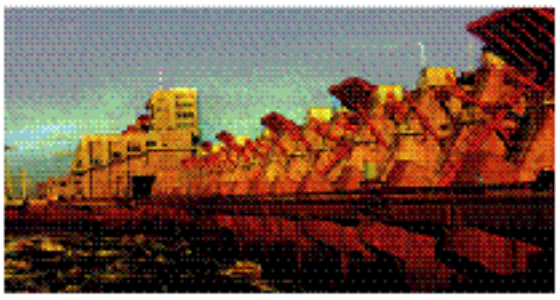


SILENT FLOOD

The increase in water - level in the Iberá marshes

The new threat from the Yacyretá Dam



FUNDACION
VIDA SILVESTRE
ARGENTINA

Daniel E. Blanco & Aníbal F. Parera
Co-ordination: Marcelo H. Acerbi

Enlarged and updated version

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SILENT FLOOD

The increase in water - level in the Iberá marshes

The new threat from the Yacyretá Dam

Daniel E. Blanco & Anibal F. Parera
Co-ordination: Marcelo H. Acerbi

Freshwater and Wetlands Program

Enlarged and updated version
2003

Presentation

The Iberá marshes in the province of Corrientes –one of the largest wetlands in Argentina – are today threatened by the excess of water: a sustained flood which can bring about important changes in the ecosystem. There are strong indications that the works related to the Yacyretá Dam are responsible for these changes. This situation could be seriously worsened by the anounced increase in the water-level of the lake behind the dam to 83m from its current level of 76 m.

As a continuous source of fresh water, a cattle fodder, a sump for carbon and a unique reservoir for threatened wildlife, Iberá plays a major role for the human population living on its periphery. But it is besides a part of the landscape and culture of the inhabitants of Corrientes as well as the area where nature tourism activities generate a growing national and international interest.

In 1989 and 1990, coinciding with the diversion and partial damming of the Paraná river in preparation for Yacyretá, the water-level in the Iberá marshes increased by almost one meter. According to specialists, neither rainfall nor a possible blockage of the river which naturally drains the ecosystem (the Corrientes river) can account for such increase. There is every indication of an underground *seepage* of water towards Iberá from Yacycretá. The lake behind the dam is separated from the Iberá marshes by only a few hundred meters.

In this document, Fundación Vida Silvestre Argentina discusses the causes and effects of this serious problem and puts forward its recommendations. **In the absence of independent studies that clarify the degree of responsibility held by Yacyretá, Vida Silvestre categorically opposes the development of the new works related to the increase in the water-level to 83m.** If the seepage is proven to be significant, the Yacyretá Binational Entity ("EBY" – Entidad Binacional Yacyretá) must assume its obligation to compensate for the impacts already caused and prevent all future ones.

When we presented the first edition of "The Silent Flood", we sustain that it was usual for the EBY to subject the Argentines to a tradition of non-compliance. Over the last two decades, the EBY has sistematically ignored the recommendations raised by this and many other NGOs in connection with the environmental responsibilities assumed. Now, after 18 months of work in which FVSA has demonstrated a constructive and independent attitude towards the EBY, we must assume that, although EBY´s attitude has shown some symptoms of change, it has not been modified significantly.

Different factors may be causing this *silent flood*. The foreign currency returns for

the sale of electricity is one of them. The repayment of the heavy debt incurred for the construction of Yacyretá may cause the World Bank or other financial institutions, eager to recover their investment, to rush the decision to increase the water-level.

If the price of these decisions is to wipe the Iberá marshes off the map, turning a complex and valuable ecosystem into a simple stretch of water and flooding neighboring areas, the national and international authorities involved must be made fully aware of such facts. And they will have to answer to the present and future generations for the irreversible consequences.

Javier Corcuera
Executive Director
Fundación Vida Silvestre Argentina
Buenos Aires, January 2003

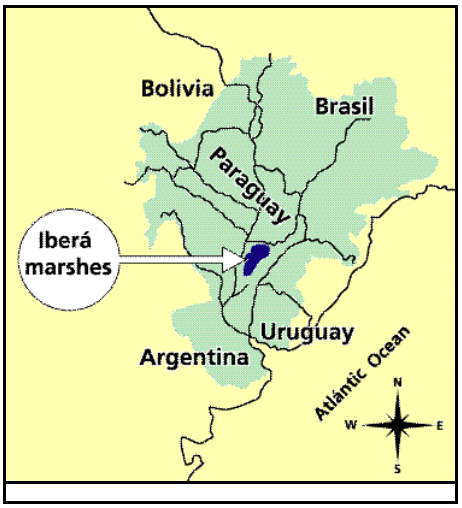
Contents

FUNDACION VIDA SILVESTRE ARGENTINA

1 Background

1.1. The Iberá marshes

The Iberá marshes lie in the center and north-east of the province of Corrientes, Argentina, and are a unique system of wetlands in the world and one of the largest in Argentina (figure 1). Because of their excepcional characteristics and the fact that they have been kept isolated and almost undisturbed over the centuries, they have recently been recognized as a separate eco-region known as the Iberá Marshes (Administración de Parques Nacionales 1999).



This system of marshes, lagoons and swamps is part of the Río de la Plata watershed and covers an area which fluctuates from 7,800 to 12,000 square kilometers (Neiff 1999) or 13,000 according to other sources. Often referred to as a "macrosystem", Iberá can be described as a vast plain barely sloping NE-SW, fed by rainfall in surface, and which drains into the mid-Paraná via the Corriente river. Before reaching the collector bed, a series of lagoons "chained" by a vast and profuse network of channels diversely defined and active. (Bonetto 1998).

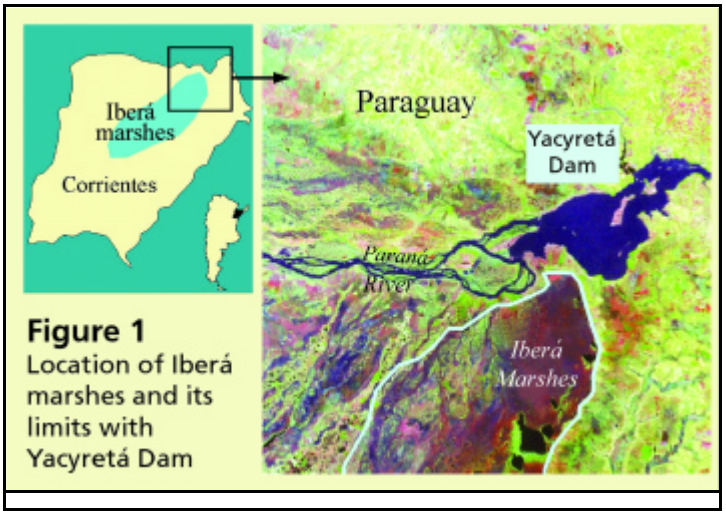


Figure 1
Location of Iberá marshes and its limits with Yacyretá Dam

Originally the system was connected to the Paraná river until the late Pleistocene, some 3,000 years ago (Neiff 1999) when the variations in the flooding pulse became more predictable and decreased. Since then the Iberá

marshes have been isolated from the fluvial pulses and almost all their water has come from local rainfall. In this context, water losses are by evapotranspiration through the vegetation biomass and by drainage via the Corriente river.
The Iberá wetlands can be divided into three categories: "permanent" (denomination given to lagoons, marshes and streams), "temporary" (denomination given to swamps and flooded grasslands), and "lotic", flowing in and out and secondary channels (Neiff 1981a, 1981b).
One of the most remarkable characteristics of the Iberá marshes is the "embalsados", the massive carpets of floating vegetation around the bodies of open water. These are true floating islands composed of accumulated dead or decomposing organic matter. Deeply-rooted plants of a considerable size can be found on these soils of acid pH ("histosoles")–including tree species like the seibo (*Erythrina cristagalli*) or the laurel (*Nectandra falcifolia*)-, the system acting like a veritable tropical peat-bog (Neiff 1999).

1.1.1. Biodiversity

The Iberá marshes show a high biodiversity. Vertebrates includes over 44 species of mammals (S. Heinonen pers. com.), some 40 species of reptiles and 35 of amphibians (T. Waller pers. com.), and between 250 and 300 species of birds (Fraga 2001). A remarkable diversity of fish has also been recorded, with some 80 species cataloged (Bonetto 1998). Iberá can be divided into two "ichthyic sub-watersheds", an eastern one which is isolated from the influence of the Corrientes river by vegetation (which would act as a barrier for fish) with a lesser fish fauna, the most common predatory species being the Piranha (*Serrasalmus* spp.) and the pike-like Tararira (*Hoplias malabaricus)*, and a western one which, due to the interconnection of a multitude of streams and channels, allows the presence of fish from the Paraná, such as the Dorado (*Salminus maxillosus*), the bottom-feeding Sábalo (*Prochilodus platensis*)

Photo: A. Parera

and the fresh - water sting-ray (*Potamotrygon brachyurus*) amongst others.
The marshes and adjacent areas are home to fair populations of threatened species of mammals such as the Marsh Deer (*Blastocerus dichotomus*), the Pampas Deer (*Ozotocerus bezoarticus*) and the Maned Wolf (*Chrysocyon brachyurus*), as well as other species which are traditionally hunted for their pelts or skins such as the Paraná Otter (*Lontra longicaudis*), two species of Cayman (*Caiman latirostris* and *C. yacare*) and the water-boa Curiyú (*Eunectes notaeus*). In the area there are also species of birds which are threatened and of restricted distribution (García Fernández *et al.* 1997), such as the Ochre-breasted Pipit (*Anthus nattereri,* endangered), the Saphron-cowled Blackbird (*Xanthopsar flavus,* endangered), the Dominican Monjita (*Xolmis dominicana,* vulnerable) and the Strange-tailed Tyrant (*Alectrurus risora,* vulnerable).

1.1.2. Environmental and social benefits

Wetlands are amongst the most productive ecosystems in the world and yield important economic and social benefits, which can be described in terms of resources, services and attributes (Canevari *et al.* 1999).
The Iberá marshes provide man with important resources, such as fish (Dorado, Sábalo, Boga, etc), reptiles (Caymans) and mammals like the Capybara (*Hydrochoerus hydrochaeris).* Moreover, the system fulfils a series of significant functions, such as the provision of fodder and drinking water for cattle, the storage of carbon in living plant matter and proves potentially valuable for the development of recreational and tourist activities.
Iberá houses some 12 human settlements, including villages and hamlets, and over 100 farms mainly engaged in cattle breeding, thus becoming the sustenance for many peripheral townships (T. Waller pers. com.), which depend on this system. Other economic activities in the region include the cultivation of rice and forest plantations (pine and eucalyptus), while a small proportion of the population depends on subsistence hunting.

Photo: A. Parera

Finally, the Iberá marshes have a great symbolic and cultural significance, probably being the most typical natural setting in the popular image of the province of Corrientes.

1.1.3. Conservation and management

Because of their biodiversity and uniqueness, the Iberá marshes have been declared a high priority conservation at the regional scale (Olson *et al.* 1998).

The Iberá marshes are today one of the largest protected areas in the country thanks to Law No. 3771 (1983), whereby the province of Corrientes designates Iberá as a "Provincial Nature Reserve".

Section 1 of Law No. 3771 states: "*The Iberá Nature Reserve is hereby created in the Province of Corrientes, same having the following borders: to the north, National Route 12; east, the watershed between the Aguapey and Miriñay rivers; west, the watershed between the Iberá and the streams which run into the Paraná, especially the Batel and the Batelito; south, the continuation of the eastern watershed which separates the system of the streams flowing into the right bank of the Miriñay and to the north of the Pay Ubre, with an approximate surface area of 13,000 square kilometers.*"

A devastating project

In the '70's an ambitious project was developed to promote the multiple use of the Iberá system by building a canal in the area of Zanja San Miguel to divert the flood-waters of the Paraná river to the marshes, thus flooding them and forming a huge inland lake. The idea was to divert the accumulated water to the Uruguay river and its Salto Grande dam via the Miriñay river to optimize the operation and the generation of power of said dam. Other part of the water was to be channeled via the Corrientes river back into the Paraná, thus providing water for the Paraná Medio hydroelectric project (Bonetto et al. 1988). A project of such characteristics would have resulted in total devastation of the Iberá marshes and of vast areas of the Paraná's valley between Corrientes and Santa Fe.

In furtherance, on 18 January 2002 some 24,550 hectares of lagoons and marshes were designated as a *Wetland of International Importance* by the Ramsar or Wetlands Convention, which Argentina takes part.

In spite of all the efforts for its conservation, Iberá has been exposed to a series of threats, amongst which the most important are:

- Water pollution and fauna poisoning caused by the intensive use of pesticides on rice plantations and afforestations.
- Loss of natural habitat due to forestation (*Pinus eliotti* and *Eucalyptus* spp.)expansion.
- Competition of domestic cattle with native grazers such as the Marsh Deer, the

Pampas Deer and the Capybara, as well as the risk of disease communication.
- Commercial and sports hunting
- Cattle trampling and consequent soil erosion leading to indirect effects on drainage patterns such as silting up of water-courses.

Photo: A. Parera

1.2. The Yacyretá Binational Dam

1.2.1. Environmental impacts of large dams

Throughout history large dams have been promoted, amongst other reasons, for their action in moderating floods downstream. However, some revealing research by WWF (Pearce 2001), clearly shows that in many cases these big projects have aggravated the problem, as they were built without taking into consideration the occurrence of extraordinary events such as abnormally copious rainfall and floods, and often underestimating the capacity of sediment accumulation and rates of siltation of lakes.

Large dams have an effect on different aspects of the environment, hydrology patterns, aquatic and terrestrial ecosystems, national economies and socio-economic conditions of the local population (Avakian 1990).

The environmental impacts of the big projects developed in the Río de la Plata watershed have been reviewed in a report by FVSA in 1996. This report clearly points out that the environmental compensation and mitigation commitments have generally not been met (Cerutti 1996).

1.2.2. The Yacyretá Dam

1.2.2.1. Origins

The Yacyretá Dam is a joint undertaking by the governments of Argentina and Paraguay to obtain hydroelectric power from the Paraná river (27º20'S, 56º40'W). It is located about 90 km downstream of the cities of Encarnación (Paraguay) and Posadas (Argentina).

Yacyretá was built for the following purposes: 1) to produce HE power; 2) to improve the Paraná's navigability; 3) to moderate the effect of the river floods; and 4) to provide water for irrigation in adjacent areas.(Quintero Sagre *et al.* 1992).

The Yacyretá Binational Treaty was signed in December 1973 and one year later the Yacyretá Binational Entity (EBY) was established to design,

Constructive stage of Yacyretá dam. Photo: A. Fulquet

build and implement the project. The civil works started in 1984 and a part of them was finished in 1992. In 1994 the lake behind the dam was filled to 76m above sea level. Although the works related to the dam are finished and its twenty turbines are in operation [1], the waters are kept below the prjected final 83m level. Its possible increase would add to the numerous existing environmental, social and economic problems.

1.2.2.2. Yacyretá's Environmental Impacts

An analysis of Yacyretá's environmental impacts was drawn up by FVSA in 1993 (Bertonatti and Banchs 1993). This document drew attention to the serious environmental impact of the work, which would affect some 50,000 local inhabitants, both urban and rural, with deterioration in health aspects and local fishing, and the submerging of valuable archaeological fields and natural ecosystems, including some 300 islands.

The major environmental impacts identified by Bertonatti and Banchs (1993) were:

1) on the water resource – rotting of vegetation biomass; eutrophication; a rise in water-tables; accumulation of toxic organic substances and heavy metals from farming and industry and urban sewage, sedimentation; a reduction in the river's speed of flow and erosion; an increase in fluvial transport; creation of new agricultural areas; arbitrary management of water.
2) on human health – an increase in vectors of diseases and in the incidence of infecto-contageous illnesses.
3) on human settlements – mandatory translocation of over 50,000 urban dwellers, rural communities and indigenous peoples, alteration of urban infrastructure and networks.
4) on cultural heritage – loss of archaeological fields, historic-archaeological ruins and numerous historic buildings.
5) on ecosystems and biodiversity – definitive loss of between 52,600 hectares (at the 76m level) and 107,600 hectares (at the 83m level) of terrestrial ecosystems; loss of the Paraná island ecosystem; loss of biological continuity in the region due to fragmentation; loss of stretches of alluvial valleys of the streams of the upper Paraná watershed; negative impacts on threatened plant and animal species and loss of species of special value and interest such as the snails endemic to the rapids of Yacyretá-Apipé (*Aylacostoma* spp.); impacts on fish fauna.
6 other impacts – disappearance and modification of landscapes (such as the waterfalls of Apipé); disappearance of sites of tourist value; changes in climate;

1 The EBY argues that the turbines are not operating effectively because the lake is kept at the 76m level, and points out that they will only be fully operational once the 83m level is reached.

an increase in road-kills of fauna.

With a view to contribute to the minimization of the impact of Yacyretá, in 1993 FVSA drew up a series of recommendations for the EBY (Bertonatti and Banchs 1993):

1) To guarantee the EBY's economic commitment in perpetuity to maintain and fund environmental programs and actions.
2) To operate at 76m rather than at 83-84m in order to minimize the environmental impact.
3) To refrain from building the compensatory dam at Itá Ibaté.
4) To create and implement compensatory reserves totaling an area never inferior to the one to be flooded (30,000 ha in Argentina).
5) To protect and implement the compensatory nature reserve Campo San Juan, in Misiones.
6) To survey island and riverside areas in the province of Corrientes in order to identify prospective compensatory nature reserves.
7) To establish and implement a compensatory nature reserve in said area.
8) To strengthen the Iberá Provincial Nature Reserve.
9) To rescue and monitor endangered species and set up a rehabilitation and breeding center.
10) To guarantee fish migration as soon as possible.
11) To monitor fish fauna permanently.
12) To strengthen private nature reserves in the provinces of Corrientes and Misiones.
13) To comply with any and all legal environmental regulations for concessionaires.
14) To determine "do by" dates and make them known to the public.
15) To improve the infrastructure and operation of the Atunguy Wildlife Management Area (Paraguay).
16) To restore the native plant nursery and implement the reafforestation program in Rincón Santa María.

After the lake had been filled to the 76m level, other environmental impacts, which had not been predicted in the Environmental Evaluation, were detected (Quintero Sagre *et al.* 1992). The most important of them are the oversaturation of gases caused by defects in the design of the spill-ways, the effect on endemic species in the flooded area and on endangered species in the area of influence of the lake, as well as the invasion of floating vegetation islands ("embalsados") coming from the marshes within the flooded islands. All these effects have been recognized by the

EBY (EBY 2001b, 2002) and the World Bank (World Bank 1999).
Today we can add another environmental impact not predicted in the Environmental Evaluation: **the increase in water-level in the Iberá marshes due to seepage from Yacyretá lake**. This is a problem which, in spite of the evidence and the different opinions of renowned specialists, has not been seriously considered yet by the EBY, as we shall see in this document.

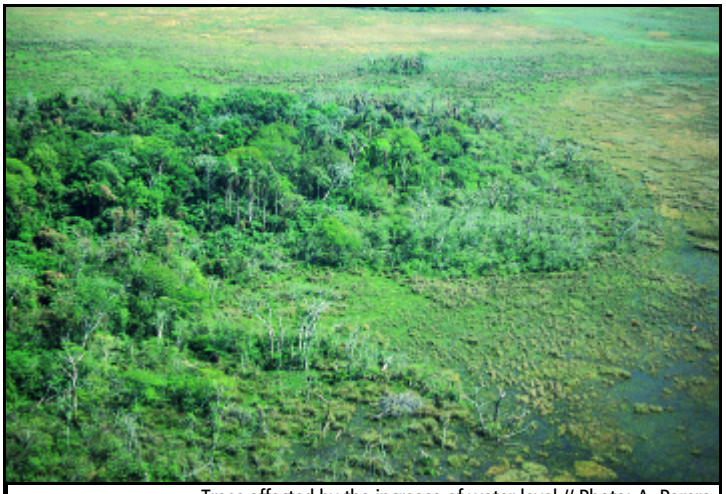
Photo: A. Fulquet

2. The Yacyretá Dam threatens the Iberá marshes

2.1. The increase in water-level in the marshes

In 1995 farmers in the Second Section of Ituzaingó within the Iberá Provincial Nature Reserve reported widespread flooding of fields and demanded that the provincial authorities had drainage channels built[2]. Such claims are well-documented in newspaper cuttings of that period.

In view of the above claims, the Corrientes Water & Environment Institute (ICAA, the agency which deals with the subject of water in the province of Corrientes) confirmed the flooding as reported by the inhabitants of Ituzaingó, as well as the increase in water-levels by some 80 cm as from 1989, measured on the hydrometric scale at Carlos Pellegrini [3].



Trees affected by the increase of water level // Photo: A. Parera

Likewise, farmers in the SW area of Iberá, gathered in the committee of the Batel / Batelito watershed ("Comité de cuenca de los esteros Batel/Batelito"), put in their claims for the flooding of fields on the margins of the Iberá. The districts most affected by the increase in Iberá's water-levels are Ituzaingó, Santo Tomé, San Martín, Mercedes, San Miguel, Concepción and Alvear, all of them within the Iberá's watershed.

> The accounts given by the rural settlers about the increase in water-level and its permanence over the past 10 years are convincing. The consequences are evident: the flooding of fields and forests and the death of trees due to the rising water-table. (T. Waller pers. com.).

2 Presentation by Councilor Andrés Zavattiero (Ituzaingó County Council, Corrientes) before the Defensoría del Pueblo de la Nación (People's Ombudsman) in October 1999.

3 Note # 016-ICA signed by Lic. Delia Acevedo, ex comptroller of the Corrientes Water & Environment Institute, and sent to the Yacyretá Binational Entity (EBY) in reference to the panel of experts summoned by the EBY (31st July, 2000).

2.2. Seepage of waters from Yacyretá lake to Iberá

In view of the increase in water-levels, some specialists started to analyze the phenomenon in order to search for an explanation, which they found in the seepage of waters from Yacyretá's artificial lake to the Iberá system.

The main reasons for arguing that the seepage between watersheds is the principal cause of the increase in water-levels in the Iberá marshes are as follows:

- The existence of a notable increase in Iberá's water-level cannot be attributed to rainfall.
- The correspondence between the increase in water-level in Iberá and the work events at Yacyretá.
- The detection of areas with thermal anomalies potentially indicating a surging.
- The existence of geological conditions permitting seepage.

2.2.1. A notable increase in Iberá's water-level cannot be attributed to rainfall

It is impossible to account for an 80cm rise in Iberá's water-level over a year and six months by merely considering rainfall.

According to the team led by Dr. Graciela Canziani, a researcher at the National University of the Center of Buenos Aires Province, a remarkable difference can be noted when comparing the average water-levels corresponding to the decade 1990-2000 to previous records. This difference is the result of an increase in the volume of water retained in the marshes, where the minimum levels recorded for the decade 1990-2000 exceed the average level observed between 1969 and 1989 (Ferrati *et al.* 2000).

This phenomenon can be clearly seen in the hydrometric scale of Iberá lagoon, in the period between April 1989 and July 1990, when an 80 cm increase was recorded for the average depth of the body of water (figure 2).

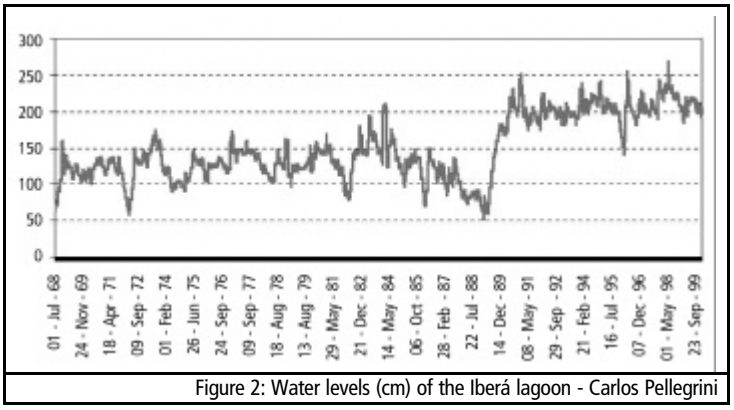


Figure 2: Water levels (cm) of the Iberá lagoon - Carlos Pellegrini

In order to study the possible causes of the increase in water-levels in the marshes, Dr. Canziani and her team devised a simple hydrological model for an isolated system

with no input of superficial waters, where the inflow variables were rainfall and the demand of evapotranspiration, and the outflow was the volume of water carried by the Corriente river. The underground balance in the system storage was also taken into account (Ferrati *et al.* 2000).

The comparison between the monthly balance resulting from said model and the measurements taken in Iberá lagoon showed that the model well reflects the general behavior (rises and falls in the water level) during the period under study (figure 3) but cannot account for the inordinate rise observed as from 1989 (Ferrati *et al.* 2000).

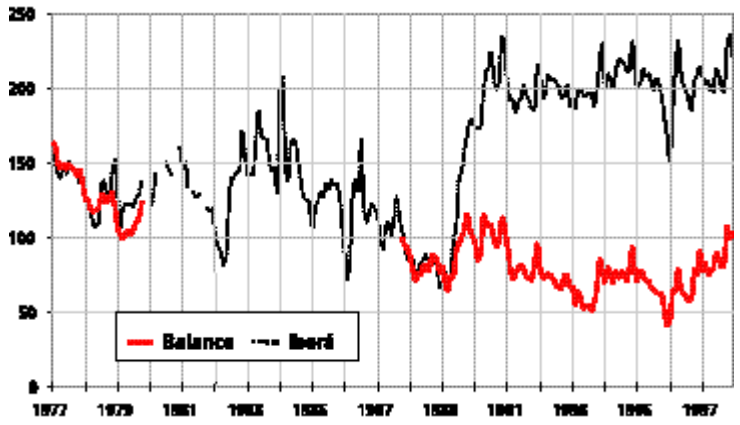


Figure 3: Graph comparing the monthly balances according to the model (expected) and the water-level of Iberá (recorded). Source: Ferrati et al. (2000).

The research team concluded that:

1) The rise in rainfall recorded in the area cannot account for the rise in water-level in the Iberá marshes.
2) The hypothesis of a stoppage in the Corrientes river (whether caused by vegetation or by an occasional rise in the water-level of the Paraná) cannot account for said rise, either. The studies showed that, even if said stoppage had taken place, such situation would not be sufficient to account for the rise observed.
3) There is no doubt that an important inflow of water not explicitly shown by the model occurred in 1989 and has been in effect since then.

These studies clearly show an inordinate inflow of underground water into the Iberá system (G. Canziani pers. com.). Though there is still no evidence that said inflow towards Iberá comes from the increased level of the Paraná at Yacyretá, specialists support this hypothesis.

2.2.2. The correspondence between the increase in water-level in Iberá and the work events at Yacyretá.

The second argument is based on the coincidence of dates on which the increase is verified and the work events at Yacyretá. The notable increase observed when comparing the average water-levels of Iberá for the decade 1990-2000 with those of previous decades (see figure 2) coincides with the start-up of the civil works for the closure of the Yacyretá Dam and the opening of the main spill-way. This reduced the channel and raised its water-level by some 3 meters, simulating a big flood.
Further research carried out by Dr. Canziani's team (R. Ferrati -Univ. of the Center of Buenos Aires Province- pers. com.) clearly showed two peaks of underground water inflow into the Iberá system (figure 4) which the team associates with: 1) the diversion of the Paraná river to build the closure of the work (between April 1989 and October 1990) and 2) the end of the civil works and the filling tests of the reservoir in 1993.

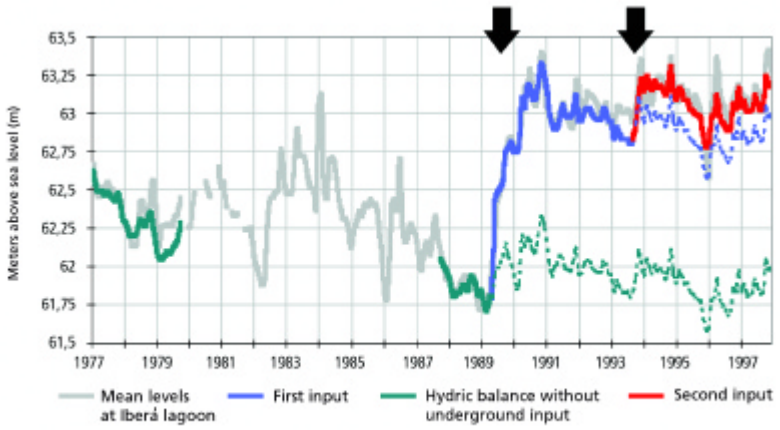


Figure 4: A more detailed graph showing the two marked increases in water-level of Iberá from subterranean seapage.Source: Ferrati et al. (2000).

2.2.3. The detection of areas with thermal anomalies indicating a potential seepage.

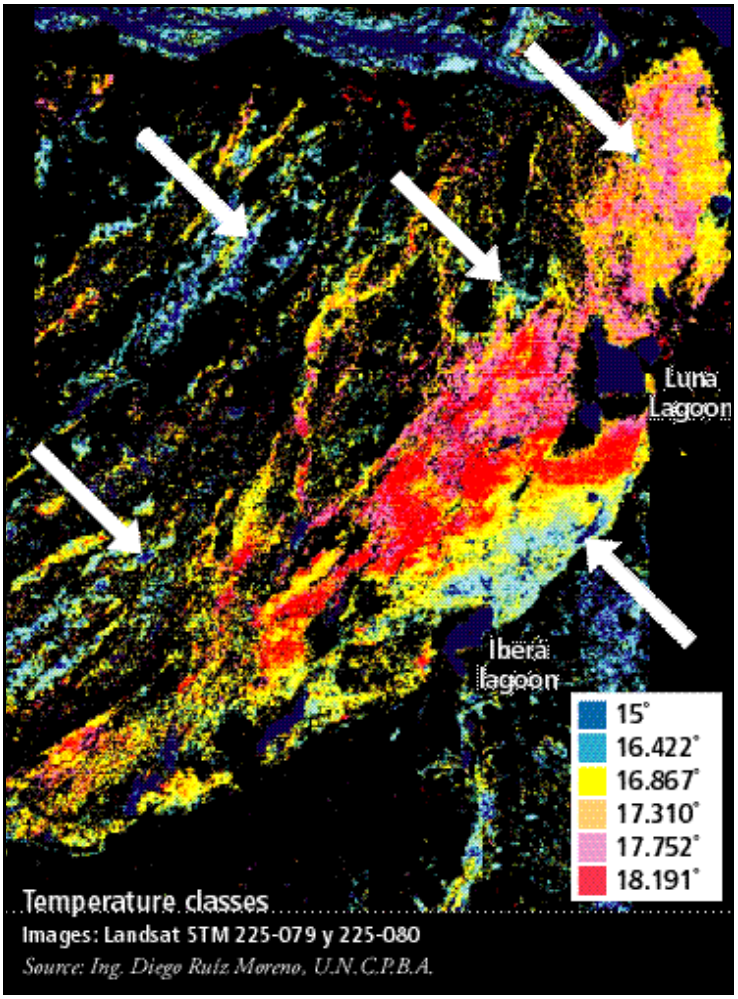
Preliminary studies recently carried out by using thermal bands of satellite images suggest the presence of areas with colder waters in the Iberá marshes[4]. Taking into account that the continuos surging of deep waters can be detected through varia-

4 Ruiz Moreno, D. 2002. Conference "Nouvi sviluppi nella modelistica ecologica attraverso dati satellitari"; delivered at the School of Mathematical, Physical and Natural Sciences. Siena University, Italy (June 2002).

tions in superficial temperature -since water is considerably colder due to the fact that it is not exposed to solar radiation -, it is possible to support the hypothesis of the existence of non-superficial inflow areas. Hence, the study of thermal bands of satellite images would allow the detection of water outflow which potentially enters the Iberá system in a subterranean manner[5].

This studies allowed the identification of large areas with a lower temperature, as it is the case between Luna and Iberá lagoons and in specific areas in the region situated towards the center-west of the wetlands (Figure 5). This places could be indicating areas of an underground inflow of water into the system.

These preliminary results add to the existing evidence regarding the potential seepage of waters from the Yacyretá Dam into the Iberá marshes, and draw attention to the need for hydrogeological studies for the whole region, and not merely in the area of the levee which separates the system from the Paraná river.



5 This type of thermal analysis is based on an unsupervised classification of the surface, on the basis of the combination of the variables obtained from the Tasselled Cap transformation (CAST 1999), that is to say, soil wetness, greenness and exposed soil, since these determine temperature. The temperature for each land class is then estimated by using specific algorithms corresponding to LANDSAT satellites.

2.2.4. The existence of geological conditions permitting seepage

The fourth argument is based on the presence of geological conditions which would favor the seepage of waters from Yacyretá lake to Iberá through a more permeable substrate located east of Ituzaingó, between Loma de Irala and Puerto Valle. Lic. Adolfo Fulquet (pers. com.) and Lic. José Luis Angeleri[6,7] have identified three regional geological characteristics which might account for the seepage from Yacyretá lake to Iberá:

1) Fracture systems identified in the basaltic rock of the subsoil

An important seepage from Yacyretá lake to the Iberá system could flow through the joint planes in the base-rock basalt, with water moving with a "turbulent flow" and forming a small underground river. The seepage would then be the result of water passing through a great number of joint planes which occur in the river-bed, in the area of the former rapids of Apipé.

This seepage would be mainly found in the proximity of Loma de Irala, but also in other areas as yet unidentified; all of which is found in the base rock at but a few meters deep, lying in a N-S direction from Santiago (Paraguay) to some 20-30 km south of national route No. 12 in Iberá.

The hydrogeological studies proposed by the Corrientes Water & Environment Institute (Angeleri 2000) were intended to determine which of these intercommunication channels would be favoring the flow between the bodies of water, the volume of such flow, the areas affected and the mitigation works to be undertaken (J.L. Angeleri pers. com.).

2) Very low-density sediments overlying the basaltic rock

These low density sandy areas overlying the basalt (between 0 and 20-30m deep) are totally saturated with water and could act as a connecting medium between the dam's lake and the marshes.

The low density of the soils between Loma de Irala and Puerto Valle was verified in studies carried out for the construction of the bases of pylons to carry the high-voltage electricity lines. The vast majority of the sediments detected were found to be oversaturated with water and arranged in low resistance "pockets" which might correspond to more supeficial paleo watercourses.

3) Existence of ancient paleo-watercourses of the Paraná river

In the area of Puerto Valle, in the proximity of the junction of provincial route No. 41 and national route No. 12, an anomaly was found which corresponds to an

6 Angeleri, J.L. 2000. Document drawn up for the Corrientes Water & Environment Institute; presented to the panel of experts summoned by the EBY - Ituzaingó, Corrientes (August 2000).

7 Angeleri, J.L. 2001. Paper on the possible seepage between Yacyretá lake and the Iberá marshes; presented in the III International Workshop on Regional Perspectives for the Development and Management of Dams in the Rio de la Plata Watershed. Posadas, Misiones (March 2001).

ancient river-bed of the Paraná, carved through the basalt and filled with sand and alluvial soil, along which arms of the Paraná river could have flowed in the past.
Geophysical studies revealed that the basalt here is some 120m deep, surpassing the average 30 to 50 m of the rock which lies parallel to national route No. 12 in the direction of Posadas.
The existence of these ancient river-beds would amplify the effect of permeable soils explained under 2) above.
The EBY's knowledge of the existence of these paleo-watercourses is documented in a memorandum drawn up by said entity dated 31 October 1989, in which a reference was made to a request from the province of Corrientes to take into account the possible alterations in the water-table at Villa Olivari, where "*sundry geotechnical and geophysical studies were carried out. The conclusions drawn indicate the existence of a very deep paleo-watercourse and the possibility of an inversion of the drainage which at present moves towards the Paraná river*" (EBY 1999).
The volume of the water flow through the sides of Yacyretá lake (which due to gravity flows towards the lowest surrounding areas) depends on the local geological conditions and the types of soil, as well as on the water-proofing works performed by the EBY. In this regard, it should be pointed out that no such work has been undertaken on the Argentine side of the lake.
These three factors might be operating jointly, at different intensities. However, all the specialists consulted agree that the abrupt increase in water-level in the Iberá marshes recorded in 1989 does not seem to have been caused by the laminar flow of water characteristic of sandy soils, but by a turbulent flow along open joint planes in the basalt.
Furthermore, water surging phenomena such as the one recorded in Estancia San Pedro -14 km south of national route No. 12 in the direction of Corrientes (A. Fulquet pers. com.)- pose a new question and show the need for research into their origin and their possible connection with the seepage from Yacyretá.

2.3. The Yacyretá Binational Entity still argues that the seepage is negligible

While aware of the existence of the above arguments (see item 2.2), the Yacyretá Binational Entity still denies the presence of the seepage from Yacyretá's lake to Iberá by describing it as "negligible". However, the existence of this phenomenon had already been informed in studies commissioned by the EBY itself and carried out by the consulting firms Lotti & Associati (EBY 1999) and Harza & Consorciados (EBY 2000a).

One of the main conclusions reached by Lotti & Associati is that the presence of Yacyretá lake may influence the hydrogeological regime of neighboring areas since its shores are mostly made up of permeable sandy deposits, which leads to the belief that an increase in the water-level of the lake might result in an increase of the flow through said deposits towards neighboring areas (EBY 1999). The same study also mentions the importance of considering such phenomenon specially in connection with the Iberá marshes due to: 1)a localized rise in the flow caused by the increased permeability of the dividing watershed Paraná/Iberá, and 2) the particular characteristics of the Iberá system, which might suffer a rise in the aquifer level with irreversible consequences (EBY, op. cit.).

> "The seepage from Yacyretá lake towards the water-tables of the marshes as calculated by the model could reach fairly important levels which will modify the piezometric morphology by raising the water-table to the surface and producing the upwelling of underground waters in areas in which these do not reach the surface in natural conditions" (EBY 1999)".

The hydrogeological model built by Lotti & Associati revealed the trend towards the increase in the seepage volume from Yacyretá lake to Iberá as a function of the increase in the levels of the dam, rising from the present 7.9 m^3/sec. (at the 75.7 meters above sea level) to 12.7 m^3/sec. at the maximum level of 82.86 meters above sea level (EBY 1999).

The study carried out by Harza & Consorciados-CIDY (EBY 2000a) shows important discrepancies as to the magnitude of the water seepage from the lake to the marshes, and concludes that such magnitude would be of 1 % of the total inflow received by the system, dismissing any significant effects on same.

The validity of the models proposed by the EBY has been questioned by renowned specialists due to lack of sufficient field measurements which support their position (which would also account for the disparity in their conclusions). Harza & Consorciados-CIDY's model, for example, does not take into account the existence of a paleo water course having different hydraulic properties, and ends up generalizing the conclusions in spite of the numerous pieces of evidence about the geological heterogeneity and complexity of the region.

On the other hand, the EBY claims that rainfall is the cause of the increased water-level in the Iberá marshes. A first analysis presented to the FVSA Committee on 6 June 2001 concludes that the water-level variations in Iberá lagoon are the result of the balance between net rainfall and the outflow of the Corriente river, rejecting the influence of underground infiltrations (EBY 2001a). However, this analysis is based on data gathered after January 1994, several years after the rise in water-levels in 1989, for which reason such conclusion fails to pro-

vide a valid explanation of the increase in water-level in the marshes.
A second study called "Hydrometeorological Diagnosis of the Iberá System"[8] –received by FVSA in April 2002- was presented in a meeting organized by the EBY in the town of Ituzaingó in May of the same year. Said study was carried out by the company EVARSA, hired by the EBY for the installation, operation and maintenance of 15 stations located in Iberá[9] and for the carrying out of the relevant studies on the basis of the data gathered.
However, said diagnosis draws conclusions which are in opposition to the ones reached by the researchers of the National University of the Center and of the INCO-DC Project (supported by the European Union), as a result of a not very clear handling of information and of the wrong choice of the initial conditions, the latter being due to the fact that the starting point for the analysis coincides with the historic flood in 1983, when one of the most important of "El Niño" events took place (see Appendix 1 for more details).

Hydric Balance of the Iberá marshes: A comparative analysis

Ing. Rosana Ferrati, Dr. Graciela Canziani and Ing. Diego Ruiz Moreno
National University of the Center of Buenos Aires Province

The studies carried out by the company EVARSA under an agreement with the Yacyretá Binational Entity (see http://www.eby.org.ar/html/ecologia.html) and by the National University of the Center of Buenos Aires Province (UNCPBA), within the framework of the INCO-DC project (see http://www.unisi.it/wetland) characterize the Iberá marshes hydro-meteorologically and analyze the variables governing the superficial hydrology of same, coming to contradictory conclusions.
According to EVARSA, the balance of the atmospheric variables and of the outflow of the Corriente river accounts for the abrupt increase in water-level in 1989-1990. According to the UNCPBA, however, there is a clear imbalance which shows the need to revise the hypothesis of an underwater inflow.
Both studies come to contradicting conclusions as a result of differences in the definition of the initial conditions and the hypothesis outlines (underground inflow into the system). The UNCPBA uses data gathered as from 1969, which makes it possible to notice the dramatic change in the average level as from 1990 and observe the evolution of the dynamics of the system in response to the variations in rainfall and the maximum flow rates of the Paraná river. EVARSA, on the other hand, only relies on data as from 1983, when the first "El Niño" event took place and the system recorded one of its most important floods. Thus, the starting point of this analysis is a historic flood. The results so obtained lead to the belief that as from 1983 the system would be suffering a dry phase (when it was in fact regaining its average levels of the '70s) and then, when the level increased in 1989-90, the system would be "recovering" its historic level.

See **Appendix 1** for more details.

8 see http://www.eby.org.ar/ecologia.html
9 see technical detail at http://www.eby.org.ar/monitoreo_sistema_ibera.html

2.3.1. The vision of the Panel of Experts

In answer to the numerous demands from governmental agencies and NGOs of the provinces of Corrientes and Misiones, the Yacyretá Binational Entity summoned a panel of experts to analyze the "Interrelationship of the Yacyretá Dam and the Iberá marshes", panel which met in Ituzaingó in August 2000 (EBY 2000b).

The panel concluded that the underground seepage from the Yacyretá Dam to Iberá, if any, is minimal and of very little significance in comparison with the inflow of rainfall into the system, and recommended a program for the monitoring of Iberá to establish any correlation between rainfall and water-levels in different areas of the marshes. The EBY later hired the company EVARSA to carry out said task[10].

The conclusions drawn by the panel of experts were surprising as they were reached exclusively on the basis of mathematical models and failed to include field studies of the behavior of underground waters.

10 EBY 2001- minute # 444, 8th Feb. 2001. Resolution # 4557/01.

3. The impact of the Yacyretá Dam on the Iberá marshes

3.1. Effects of the increase of the dam's water-level to its present 76 meters

The increase of water-level in Iberá is a threat to the integrity of the whole system. According to Ferrati *et al.* (2000) "*the manifest consequences of this rise in water-levels result in the heavy loss of productive land on the northern and western edges of the system. The consequences within the system as regards the increase in flow and transport of sediments, the vegetation dynamics and the quality of natural habitats, as well as the degree of the impact that these changes will have on the environmental quality and on native plant and animal species are absolutely unknown.*"

The following are the impacts of the increase in water-level:

On the habitat and vegetation:

- Flooding of terrestrial habitats.
- Drowning of trees and loss of woodland due to rising water-tables.
- Soil changes due to alterations in underground water patterns.
- Loss of spatial heterogeneity through flooding of ecotonal habitats (D. Ruiz Moreno pers. com.).
- Possible changes in the chemical composition and primary productivity of waters.
- Changes in the dynamics of "embalsados" and in the mobility of floating vegetation due to an increase in water depth, which might result in the loss of habitat for many fauna species.
- A specific impact on emergent and rooted aquatic plants which flower at the surface (J.J. Neiff pers. com.).

Acces to "El Recodo" farm (totally flooded). Second section, Ituzaingó department. Photo: A. Fulquet

On productive activities:

- Loss of over 100,000 hectares of productive land due to flooding (mostly in the district of Ituzaingó), including cattle range, whose recovery time is very long after prolonged saturation (Ferrati *et al* 2000).
- Flooding of some 200,000-250,000 hectares of productive land in the Batel/Batelito watershed due to a rise in the water-tables (Corrientes Water & Environment Institute 1995).
- Loss of 50,000 heads of cattle over the last 5 years, only in the district of Ituzaingó (Ferrati *et al.* 2000).
- Damage to forest plantations in the NE and the SW of the system due to a rise in the water-tables.
- Negative impacts on tourist activities.

On the fauna:

- Reduction in and loss of critical fauna habitats, with a more serious impact on ecotonal species. This could result in a reduction in the diversity of birds and other vertebrates with the consequent loss of biodiversity. The following is particularly expected:

  - Reduction in the area available for the Marsh Deer (*Blastocerus dichotomus*) as floating islands destabilize, forcing the species to migrate towards the high lands around the system, where farms are located, with the consequent threat to the species. This would be one of the most affected mammals (M. Beccaceci pers. com.).

  - Loss of habitat for the Pampas Deer (*Ozotoceros bezoarticus*) in areas of tall grasslands adjacent to Iberá, which could be affected by rising water-tables (Parera and Moreno 2000).

  - Permanent flooding and loss of refuges and resting areas for species such as the Capybaras (*H. Hydrochaeris*) (Quintana 1999).

  - Loss of feeding and nesting sites for waterbirds (Blanco 1999), including rails (genera *Porzana, Aramides, Porphyrio* and *Laterallus*), herons (some 11 species), storks and waterfowl inhabiting the area (Fraga 2001).

  - Loss and reduction of habitat for grassland passerine birds such as the Strange-tailed Tyrant (*Alectrurus risora*) and the Saphron-cowled Blackbird (*Xanthopsar flavus*), in the case of the latter, with an increase in the genetic barrier between the populations of Paraguay and Argentina (Fraga *et al.* 1998).

Loss of Cayman (*Caiman*) nests due to a greater flooding of "embalsados" and changes in nesting habitats, with mid- to long-term alterations in the sex structure of the population and possible demographic consequences difficult to predict (T. Waller pers. com.).

3.2. The potential effect of raising the level to 83 meters

With an increase in the level of the dam lake from 76m to 83m, a total of 107,600 ha will be permanently flooded. Of these, some 105,000 ha correspond to natural ecosystems, undisturbed by human activities (World Bank 1999): 71,000 ha of wetlands (68%), 18,000 ha of grasslands (17%) and 16,000 ha of riverine gallery forest habitat (15%).

The specialists consulted agree that the increase in the lake's level will aggravate the environmental impacts today observed in the marshes. However, the lack of studies about the behavior of underground waters makes it impossible to predict the magnitude of the impact.

According to Ferrati *et al.* (2000) "*the 83 meters above sea level would imply, in addition to the worsening of the situation in the province of Corrientes and the uncertainty as to the hydric behavior of the Iberá system, the flooding of 108,000 ha caused by the dam, the relocation of the industrial district in Posadas and of more than 100,000 of its inhabitants, all this without considering the disturbances caused in the neighboring Republic of Paraguay.*"

Level of dam (m)	Total area affected (ha)	Flooded land (ha)
76	110.000	52.600
83	166.600	107.600

Source: Díaz Peña y Stancich (2000)

According to the Lotti & Associati report (EBY 1999), at the present level of 76m the waters of the dam drain permanently by underground seepage from the Paraná to the Iberá marshes, continuously feeding the water-tables of the system. With an increase in the level to 83-84m, "***the volume of water seeping from the river will unavoidably increase***" (EBY op. cit.).

However, the Iberá system will not be the only one affected. Because of the interconnection of this system with the Batel/Batelito watershed (Agua & Energía Eléctrica 1979), the latter might also be seriously affected by a rise in the dam's level.

Furthermore, even more serious impacts than the ones observed at present would take place. According to Prof. Juan José Neiff, Director of the Littoral Center of Applied Ecology (CECOAL-CONICET), a rise in water-level would change the complex dynamics of the "embalsados", which could suffer modifications, and then float freely and be exposed to extraordinary windstorms (which occur on the basis of multi-annual cycles), thus changing the physiognomy of the lagoons and even drifting to block the proper drainage of the whole system.

From a strictly environmental point of view, the World Bank argues that the operation of the dam at an intermediate level of between 78 and 80m is the best option in the long term, since in this case the additional environmental impacts would be low (World Bank 1999).

3.3. Claims and concerns of different sectors

The rise in water-level in the Iberá marshes became a matter of concern for the local residents, the province of Corrientes, the Honorable Senate of the Argentine Nation, the Argentine Secretariat of Sustainable Development and Environmental Policy and a large number of NGOs, all of whom showed worry about the future of this wetland of provincial, national and international importance.

3.3.1. Farmers and the province of Corrientes

The flooding of vast acreages, including some highly productive agricultural and cattle-breeding lands, has been reported on several occasions by the Government of the province of Corrientes, municipal authorities, intermediate associations and the residents of the Iberá watershed.

One of the claims was made by the Sociedad Rural of Ituzaingó before the Corrientes Water & Environment Institute (ICAA, in the province of Corrientes), in an attempt to find a solution to the prolonged flooding of an area of about 200,000 hectares (D. Acevedo pers. com.).

Said claims were expressed in 1995 by means of a registered letter sent to the EBY, and were later channeled through a preliminary injunction proceeding filed by the ex-Deputy César Galarza López[11].

In October 1999 the Municipality of Ituzaingó, province of Corrientes, lodged a complaint before the Defensoría del Pueblo de la Nación (People's Ombudsman) in relation to different environmental problems associated with the Yacyretá Dam, including the inter-watershed seepage and its possible connection with the flooding of over 180,000 ha of productive land [12].


panorama productivo provincial

Transvasamiento Yacyretá - Iberá

Miente la EBY a la provincia y el país?

La posición del Municipio

Yacyretá - Iberá

EL SILENCIO DE LA EBY

Inundación de campos: "A partir del llenado del embalse de Yacyretá los reclamos se hacen más intensos"

Different newspapers have documented strong claims from Corrientes society to EBY.

11 Registered letter to the EBY (06/27/95) and preliminary injunction proceeding filed against the entity by ex-Deputy César Galarza López before the Federal Court of Corrientes (08/01/95).

12 Presentations by Councilor Andrés Zavattiero of the Ituzaingó County Council, Corrientes, before the Defensoría del Pueblo de la Nación (Oct. 1999 and May 2000).

The Senate of the Argentine Nation also expressed its concern about the seepage between the Yacyretá Dam and the Iberá marshes and the possible consequences of an increase in the dam's level to 83m (in agenda # 715, 4 September 2001). The text points out that in 1992 a panel hired by the EBY "*had warned of the lack of information concerning underground waters, drawing attention to the existence of areas with altered basalt or open joint planes which offered a certain permeability"* and recommended *"carrying out a study to assess said aspect, that is, the magnitude and response of the piezometric levels according to the variation in the water-levels in the lake for the different areas which might be affected*"[13].

In spite of the numerous claims, the EBY has given no serious and committed answers to all these questions, and no technical precisions about the studies to be carried out to determine the seepage between watersheds.

3.3.2. The National Environmental Authority

Concerned about this subject, the Sub-secretariat of Environmental Management and Policy (Secretariat of Sustainable Development and Environmental Policy of the Argentine Nation) organized a workshop in Buenos Aires on 27 October 2000. After analyzing the potential effects of raising the dam's level above the 76m mark and considering the lack of basic information, it was agreed that "*the **precautionary principle** should be observed, so as to adopt, as soon as possible, any and all measures which will reduce the mentioned uncertainties, thus permitting decision-taking*" (Sub-secretariat of Environmental Management and Policy 2000).

One of the conclusions drawn by this workshop stated that "*there is evidence of a large number of alterations in the ecosystem, caused firstly by the rise in water-levels in the marshes, which has resulted in damage to different components of the habitat, such as wildlife and native plants, productive activities*" (Sub-secretariat of Environmental Management and Policy 2000).

A few days after the workshop, Lic. Patrouilleau, Undersecretary of Environmental Management and Policy, resigned his post. Subsequently, the ex Undersecretary started proceedings before the Defensoría del Pueblo de la Nación (2 November 2000), requesting the EBY the adoption of measures to prevent and/or mitigate the environmental impact resulting from an increase in the operational level of Yacyretá.

13 Report drafted by ex National Senator Dr. José Antonio Romero Feris on the watershed seepage from Yacyretá to the Iberá marshes (03/27/2001).

Considerations on the report drawn up by the People's Ombudsman

Dr. Juan Rodrigo Walsh, Fundación Ambiente y Recursos Naturales

Following the proceedings started by the Subsecretariat of Environmental Management and Policy, in June 2002 the People's Ombudsman drew up an Institutional Report on the problems connected with the seepage between Yacyretá and the Iberá marshes.

Said Institutional Report deals with the problem from two different perspectives: one, of a legal-institutional nature, and the other, related to the hydrologic hypotheses and the alleged influence of the dam (and the increase in its level to reach the maximum design level) on the Iberá system. As regards the latter, the Report analyzes the technical measures adopted by the EBY to identify any possible negative effects of the dam on the marshes.

A critical analysis of the Report allows the conclusion that same is a well-documented description of the technical background referred to the seepage problem, without examining its contents in depth. From the legal point of view, apart from pointing out the need for a dispute-solving mechanism, it fails to make a deep examination of the relationship between jurisdictional capacities and authorities in the light of the 1994 constitutional amendment, taking into consideration the particular nature of the EBY as an entity subject to public international law. Likewise, little value is attached to Section 41 of the amended Constitution and the need to comtemplate, within that context, the possible damage to the ecosystem of Iberá which might be caused by the dam operating at its maximum design level.

See **Appendix II** for more details

3.3.3. Non-governmental organizations (NGOs)

Numerous Non-governmental Organizations have expressed their concern for the increase in water-level in the Iberá marshes, as well as their opposition to raising the level of Yacyretá lake; such NGOs are Taller Ecologista (Santa Fe), Fundación Proteger - Coalición Ríos Vivos (Santa Fe), Centro de Derechos Humanos y Medio Ambiente - CEDHA (Córdoba), Red de Asociaciones Ecologistas - RAE (Misiones), Foro Ecologista de Panamá, Fundación Eco la Paz (Entre ríos), Fundación para la Defensa del Ambiente - FUNAM (Córdoba), Fundación Iberá (Corrientes), Sobrevivencia – Amigos de la Tierra (Paraguay y Argentina), International Rivers Network - IRN (Berkeley, USA), Center for International Environment Law - CIEL (Washington, USA) and Fundación Ecos (Uruguay).

On 4 August 2001, several environmental and social entities started proceedings before the People's Ombudsman in connection with the rise in the level of the Yacyretá Dam. The document submitted before the Ombudsman emphasized the need to keep the level of the lake at the present 76m, and accused the EBY of ignoring the Argentine environmental policy authority and the National Congress, violating Section 41 of the National Constitution.

4. Discussion

All the specialists consulted agree that the rise in Iberá's water-level is an unforeseen impact of the Yacyretá Dam, as a result of the seepage from the lake to the marshes. However, the lack of field data and of an independent hydrogeological study precludes a proper assessment of the magnitude of the phenomenon.

It should be pointed out that so far the prediction and forecast of the environmental impacts of large dams have been limited by the poor attention attached to environmental subjects, a lack of basic reliable data and an inability to model these complex systems with high-quality information. (CMR 2000).

The lack of basic information has even been admitted in the studies carried out for the Yacyretá Binational Entity (EBY). The "Macroregional Hydrogeological Study" drawn up by Lotti *&* Associati (EBY 1999) points out the need to supplement and corroborate the existing information on: 1) the morphology of the basal over a fairly wide area; 2) the directional lie of the paleo-watercourses detected; 3) the water-table levels and the permeability of sediments in a part of the coast levee; 4) the water-table levels in the interior of the marshes; 5) the flow volumes of major rivers and streams originating in the marshes; 6) the climatological data of the interior of the marshes; and 7) the lake levels along the shoreline.

The World Bank has also drawn attention to the urgent need for a satisfactory assessment of the variations in hydrostatic levels, before raising the dam's level above the 76m mark[14].

The urgent need for hydrogeological studies to determine the volume of the seepage has been emphasized by many specialists knowing the system. The INCO-DC Project team ("The Sustainable Management of Wetland Resources in Mercosur"), an international group of researchers from Argentina, Brazil and Europe that have worked in the Iberá marshes, has expressed its concern for the negative consequences of the increase in water-level in the marshes and has emphatically recommended an "*in-depth environmental and impact study before taking any measures which might have unforeseen results, such as the increase in the level of the Yacyretá Dam's lake*" (INCO-DC 2000).

There are numerous antecedents which emphasize the need to study the behavior of the underground waters in the region. In this sense, the Corrientes Water & Environment Institute (ICAA) drew up a Program of Hydrogeological Research in the area where the possible seepage might be taking place and a Proposal to

14 Report drafted by former National Senator Dr. José Antonio Romero Feris on the watershed seepage from Yacyretá to the Iberá marshes , 03/27/2001.

Monitor Underground Waters (Angeleri 2000), submitted before the Panel of Experts summoned by the EBY in the year 2000, but which to date has not been taken into consideration by that entity.

The need to install water-table meters to study the behavior of underground waters dates back to 1989, when Harza *&* Consorciados alerted about the "*convenience of installing observation wells on the left shore of the Paraná in the area of San Miguel-Puerto Valle-Santa Tecla*" (EBY 1999).

The EBY's Program of Environmental Management (PMMA – Sub-program of "Environmental Operation of the Dam") mentions the setting-up of a network to monitor the levels of underground waters so as to assess their behavior, including the bordering area between the lake and the Iberá system (EBY 2001b, 2002). FVSA, together with other NGOs, academic institutions and the producers' associations of the area, demanded that the EBY should carry out said studies with the participation of an idependent technical group, both for task planning and performance, with a view to ensuring a transparent validation of the results to be obtained.

The Iberá-Yacyretá forum

In view of the limited institutional response and the need to ensure transparent mechanisms for an independent study of the seepage phenomenon, the "Iberá-Yacyretá Forum" was set up on 18 October 2001, within the framework of the "Conference on Participation Yacyretá Dam-Iberá Marshes: hydrology and hydrogeology of both systems", organized by the EBY and held in Posadas, Misiones [15].

The Iberá-Yacyretá Forum was made up of the attending entities, viz. Fundación Vida Silvestre Argentina, Batel-Batelito Watershed Committee, Municipality of Ituzaingó (province of Corrientes), Salvador University, Geology and Mining Bureau (province of Misiones), CECOAL-CONICET, Bureau of Natural Resources of the province of Corrientes, National University of Misiones, National Water Institute (INA), National University of the Northeast, Human Rights and Environment Center-CEDHA, Rural Society of Ituzaingó, Fundación Proteger-Coalición Ríos Vivos, PECOM Forestal, Corrientes Water and Environment Institute (ICAA) and Network of Ecology Associations (RAE).

The Forum aims at ensuring transparency mechanisms to assess the magnitude of the seepage from the Yacyretá Dam to the Iberá Marshes. Thus, an "Independent Technical Group" was created to advise on and monitor the tasks carried out by the

15 Minute No. 1 of the Iberá-Yacyretá Forum. Posadas, Misiones (18 October 2001).

EBY in connection with the assessment and mitigation of the existing and/or potential environmental impacts on the Iberá marshes.
Unfortunately, the limited institutional response to make progress in the diagnosis and solution of the seepage problem, together with a failure to enforce environmental laws, perpetuates the threat to the Iberá Marshes and a vast region of the territory of the province of Corrientes, and consequently, to the heritage of the Argentines.

Critical revision of the proposals for hydrogeological studies recommended to study the seepage phenomenon

Lic. Adolfo Fulquet, Sociedad Rural de Ituzaingó
Lic. José Luis Angeleri, Cuenca del Batel - Batelito

This revision includes the reports drawn up by the Corrientes Water and Environment Institute (ICAA), the consulting firm Harza & Consorciados-CIDY, the "Panel of Experts" summoned by the Yacyretá Binational Entity (EBY), the Sub-secretariat of Hydric Resources of the Argentine Nation, the work of National ex Senator Romero Feris and the report produced by Dr. Miguel Auge for the Inter-American Development Bank (IADB). Appendix III shows a chart synthesizing the recommendations as to the technical requirements specified in said reports to study the seepage phenomenon.
Most of the documents revised are based on the permeability study of the sediments overlying the basalt through drilling, geophysical trials, a study of the physical-chemical properties of aquifers, measurement of the depth of phreatic or non-phreatic water, measurement of the depth of water in some lagoons within Iberá and in simulation models.
All the studies -except for the ones produced by the ICAA, the National ex Senator Romero Feris and the Sub-secretariat of Hydric Resources of the Argentine Nation- wrongly suppose that the basaltic rock is impermeable. For this reason, the main objective of all the recommendations is to try and determine the hydrogeological properties of the sedimentary cover-wrapping. The recommendations of the Panel of Experts, of the consulting firm Harza (based on the recommendations of the report produced by Dr. Miguel Auge) and of the EBY itself consider the basalt in the area totally impermeable.
The Iberá-Yacyretá Forum argues it is indispensable to study again the physical-mechanical behavior of the basaltic rock, in order to determine its actual secondary permeability.
This premise constitutes the main objective of the forum, that is, to accurately measure the magnitude of the water leakage in the basalt underlying the permeable sands of the Formación Ituzaingó and to assess the manner in which this phenomenon might be affecting the Iberá marshes, one of the most important wetlands in Argentina.

See Apendix III

5. FVSA is opposed to the advance of Yacyretá whatever the environmental cost

5.1. All the environmental commitments assumed must be complied with

The Yacyretá Binational Entity (EBY) must show its complete compliance with the environmental compensation and mitigation commitments previouly assumed:

1) Implementation and proper management of the compensatory reserves (PMMA: Program of Nature Reserves and Biodiversity):

Iberá Provincial Reserve:

- Immediate implementation of the Camby-Retá, Yaguareté Corá and Itatí Conservation Units, regardless of the increase in the dam's water-level, as undertaken by the EBY in 1996, to comply with the preservation objectives set in 1994.
- Drawing up of a "Master Plan" for the Iberá Reserve providing a proper framework for the integrated management of the conservation units, in order to avoid jurisdictional confusions and overlapping.

Other protected areas

- Implementation of the remaining protected areas programed for the present 76m level (EBY 2001b, 2002), including the expropriation and setting-up of the "Campo San Juan" nature reserve and the enlargement of the "Teyú-Cuaré" Provincial Park (both in Misiones).

2) Protection of species of interest (PMMA - Program of Nature Reserves and Biodiversity):

- Snails of Apipé: to continue supporting the institutions engaged in the breeding of these species in captivity (now extinct in the wild because of Yacyretá), and implement their prompt reintroduction into their natural habitat.
- Grassland birds: to survey the Temperate Grasslands Savannas and Shrublands eco-region for the identification of IBAS (Important Bird Areas) as proposed by Aves Argentinas.
- To assess the impact on indicator species which could be affected by the rise in water-level in the Iberá marshes and its periphery (Marsh Deer, Pampas Deer, Maned Wolf and Caymans, amongst others).

5.2. Evidence must show that the benefits of the 83m level will not be outweighed by the damage caused thereby

The construction of the Yacyretá Dam has meant a colossal effort for the country, as considered in terms of the money invested, the debt acquired or the effective environmental impact on nature and the people living in the affected regions. This is a work which has demanded much more money and time than originally estimated, with a financial return which also seems to be much lower and delayed than expected.

How much more will we invest, or resign, as seen from the environmental point of view, in our effort to favor the development of this undertaking? What is the threshold that makes damage outweigh the benefits ?

We Argentines need, and Fundación Vida Silvestre Argentina demands that the EBY should give, answers to these questions before proceeding to raise the dam's level, thus flooding forests, fields, and new housing.

FVSA demands an **independent and reliable study of the present and future behavior of the seepage of waters from the dam to the Iberá marshes**. This information must be provided by hydrogeological studies of direct underground measurement, which analyze the underground behavior of water at the level of the basalts and not only of the superficial sands, with the **participation and support of academic and technical institutions** working in this field, and with a **methodology accepted and shared** by said institutions, under conditions of absolute transparency and clarity.

The result of these studies will permit the assessment of the **true magnitude of the present impact** of the seepage, as well as its future behavior with the possible increase in water-level. This information on the one hand, and the **economic benefits** derived from an improvement in the operation of HE power production on the other, are **essential** to determine what is the best alternative for all Argentines. Until that happens, **FVSA opposes to the increase in the level of the dam's lake**, and expresses its grave concern for the repeated expressions of the auhorities of the Yacyretá Binational Entity when they state that "*raising the level is a decision made by the national government*". **We still argue that the level must not be raised at whatever price.**

6. References

6.1. Bibliography

- Administración de Parques Nacionales. 1999. Ecorregiones de la Argentina. Componente de Política Ambiental. PRODIA-SRNyDS. Buenos Aires. 42 pp.
- Agua y Energía Eléctrica. 1979. Proyecto Batel-Batelito, provincia de Corrientes. 24 pp.
- Angeleri, J.L. 2000. Documento inédito. Instituto Correntino del Agua y el Ambiente-ICAA (presentado en el Panel de Expertos de la EBY; Ituzaingó, Corrientes, agosto 2000). 4 pp.
- Avakian, A.B. 1990. Reservoirs of the World and their environmental impact; en: The impact of large water projects on the environment (Proceedings of International Symposium, 21-31 octubre 1986): 29-36. Unesco/UNEP, Gembloux.
- Bertonatti, C. y R. Banchs. 1993. La Represa Yacyretá y su impacto ambiental. Diagnóstico y recomendaciones. Bol. Técnico FVSA No. 18. Buenos Aires. 49 pp.
- Bertonatti, C. y J. Corcuera. 2000. Situación Ambiental Argentina 2000. FVSA. Buenos Aires. 440 pp.
- Blanco, D.E. 1999. Los Humedales como Hábitat de Aves Acuáticas; en Malvárez, A.I. (ed.): Tópicos sobre Humedales Subtropicales y Templados de Sudamérica: 215-224. UNESCO-ORCYT-MAB. Montevideo.
- Bonetto, A.A. y S. Hurtado. 1998. Cuenca del Plata; en Canevari, P.; D.E. Blanco, E.H. Bucher, G. Castro y I. Davidson (eds.): Los Humedales de la Argentina. Clasificación, Situación Actual, Conservación y Legislación (Región 1): 31-72. Wetlands International Publ. 46. Buenos Aires.
- Bonetto, A.A.; I.R. Wais y G.S. Arquez. 1988. Ecological considerations for river regulation of the Del Plata Basin according to flatland characteristics. Water International 13: 2-9.
- Canevari, P.; D.E. Blanco y E.H. Bucher. 1999. Los Beneficios de los Humedales de la Argentina. Amenazas y propuestas de soluciones. Wetlands International. Buenos Aires. 64 pp.
- CAST (Centre for Advanced Spatial Technologies). 1999. Landcover Classification and Mapping. The Arkansas GAP Analysis Project - Final Report (http://www.gap.uidaho.edu/).
- Cerutti, L. 1996. La Represa de Corpus Christi y otras obras en la cuenca del Plata. FVSA. Buenos Aires. 60 pp + figuras.
- Comisión Mundial de Represas. 2000. Represas y Desarrollo: Un Nuevo Marco para la Toma de Decisiones. Informe Final (http://www.dams.org/report/espanol.html).

- Díaz Peña, E. y E. Stancich. 2000. No más daños en Yacyretá. Historia, proceso y documentos relevantes del seguimiento de la Sociedad Civil a la Represa Hidroeléctrica Yacyretá. Dossier octubre 2000 (http://www.taller.org.ar/region/yacyreta.pdf).
- Entidad Binacional Yacyretá. 1999. Estudio Hidrogeológico Macroregional del Área Costanera del Río Paraná en el Tramo entre la Presa Yacyretá y el Arroyo Yabebiry. Informe Final. C. Lotti y Associati S.p.A. (3 octubre 1999). 65 pp.
- Entidad Binacional Yacyretá. 2000a. Proyecto Yacyretá. Informe sobre la interrelación del Embalse Yacyretá y los Esteros del Iberá. Harza & Consorciados-CIDY (30 junio 2000).
- Entidad Binacional Yacyretá. 2000b. Panel de Expertos. Interrelación entre el Embalse de Yacyretá y el Sistema Iberá. Ituzaingó (1-3 agosto 2000).
- Entidad Binacional Yacyretá. 2001a. Informe sin título entregado a la FVSA el día 6 junio de 2001.
- Entidad Binacional Yacyretá. 2001b. Plan de Manejo de Medio Ambiente PMMA (febrero 2001). 35 pp
- Entidad Binacional Yacyretá. 2002. Plan de Manejo de Medio Ambiente-PMMA. 32 pp.
- Ferrati, R.M.; D. Ruiz Moreno y G.A. Canziani. 2000. Modelos de Balance Hídrico para analizar el cambio de régimen en un Humedal sujeto a perturbaciones antrópicas y climáticas. Edición Electrónica de la 6ª Conferencia Internacional del Seminario Permanente Ciencia y Tecnología del Agua. Madrid.
- Fraga, R.M. 2001. The avifauna of Estancia San Juan Poriahú (Iberá Marshes, Argentina): checklist and some natural history notes. Cotinga 16: 81-86.
- Fraga, R.M.; H. Casañas y G. Pugnali. 1998. Natural history and conservation of the endangered Saffron-cowled Blackbird *Xanthopsar flavus* in Argentina. Bird Conservation Inter. 8: 255-267.
- García Fernández, J.J.; R.A. Ojeda, R.M. Fraga, G.B. Díaz & R.J. Baigún (compiladores). 1997. Libro rojo de mamíferos y aves amenazados de la Argentina. FUCEMA-SAREM-AOP-APN. 221 pp.
- INCO-DC. 2000. Comunicado de prensa de los integrantes del Proyecto INCO-DC: The Sustainable Management of Wetland Resources in Mercosur. Mercedes, Corrientes (12 junio 2000).
- Instituto Correntino del Agua. 1995. Proyecto de "Estudio cuenca Batel-Batelito". Corrientes. 6 pp.
- Neiff, J.J. 1981a. Tipificación de los ambientes acuáticos y de interfase del Macrosistema Iberá. Informe preparado para el convenio ICA-CECOAL. Corrientes.

- Neiff, J.J. 1981b. Vegetación acuática y anfibia del Iberá, Corrientes. I: Características estructurales y distribución. II: Dinámica; en: Investigaciones Ecológicas en el Macrosistema Iberá. ICA-CECOAL. Informe Final: 14-43 (inédito).
- Neiff, J.J. 1999. El régimen de pulsos en ríos y grandes humedales de Sudamérica; en Malvárez, A.I. (ed.): Tópicos sobre Humedales Subtropicales y Templados de Sudamérica. 97-146. UNESCO-ORCYT-MAB. Montevideo.
- Olson, D.; E. Dinerstein, P. Canevari, I. Davidson, G. Castro, V. Morisset, R. Abell y E. Toledo (eds.). 1998. Freshwater biodiversity of Latin America and the Caribbean: A conservation assessment. Biodiversity Support Program, Washington D.C. 70 pp.
- Parera, A. 2001. Regreso al Iberá. Vida Silvestre 78: 8-17.
- Parera, A. y D. Moreno. 2000. El venado de las pampas en Corrientes. Diagnóstico de su situación y propuestas de manejo. FVSA Publicación Especial. Buenos Aires.
- Pearce, F. 2001. Dams and floods. WWF International. 9 pp.
- Quintana, R.D. 1999. Relación entre la estructura del paisaje en un humedal y la fauna silvestre: el carpincho (*Hydrochaeris hydrochaeris*) como caso de estudio; en Malvárez, A.I. (ed.): Tópicos sobre Humedales Subtropicales y Templados de Sudamérica: 185-204. UNESCO-ORCYT-MAB. Montevideo.
- Quintero Sagre, J.D.; R.A. Ronderos y E. Campos Cervera. 1992. Informe de Evaluación ambiental. Proyecto Hidroeléctrico Yacyretá. Banco Mundial. 138 pp.
- Subsecretaría de Ordenamiento y Política Ambiental. 2000. Síntesis de actividades y conclusiones del "Taller sobre impacto ambiental de la Represa Yacyretá: Efecto de la elevación de cota del embalse sobre el Sistema Iberá". Buenos Aires (27 octubre 2000).
- World Bank. 1999. International Advisory Panel Report on the Argentina - Paraguay Yacyretá Hydroelectric Project (octubre 1999). 77 pp.

6.2. Internet / Website information

http://www.vidasilvestre.org.ar
http://www.unisi.it/wetland
http://www.exa.unicen.edu.ar/~wetland
http://www.eby.org.ar
http://www.medioambiente.gov.ar/fauna/ramsar/esteros_ibera.htm
http://www.fundacionecos.org/docs/Conclusiones del I Taller Iberá.htm

6.3. References and specialists consulted

- Dra. Graciela Canziani, Ing. Rosana Ferrati e Ing. Diego Ruiz Moreno; Grupo de Ecología Matemática, Univiversidad Nacional del Centro de la Provincia de Buenos Aires y Proyecto INCO-DC, Tandil, Buenos Aires
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- Prof. Andrés Zavattiero, Municipalidad de Ituzaingó, Corrientes
- Lic. Manuel Quintana, MACN "Bernardino Rivadavia", Buenos Aires

6.4. Press information

- *Ituzaingó. Inundación e impacto ambiental. Pedido a legisladores*. El Libertador, 22 abril 1998.
- *Yacyretá-Iberá: Primera Nota a Adolfo Fulquet.* El Litoral, 8 septiembre 1999.
- *Yacyretá-Iberá: Segunda Nota a Adolfo Fulquet.* El Litoral, septiembre 1999.
- *Yacyretá-Iberá: El Silencio de la EBY y la posición del Municipio.* El Litoral, 29 septiembre 1999.
- *Yacyretá-Iberá. Dos márgenes y una causa común.* El Litoral, 8 octubre 1999.
- *El Iberá: gran caño de desagüe y canal auxiliar de la Hidrovía.* El Litoral, 13 octubre 1999.
- *Habla la laguna y da su testimonio.* El Litoral, 14 junio 2000.
- *Miente la EBY a la provincia y el país ?* El Litoral, 6 septiembre 2000.
- *¿Se muere el Iberá? Por Aníbal Parera*. Tiempo de Aventura, enero 2001.

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Appendix I
Hydric Balance of the Iberá Marshes: A comparative analysis

Ing. Rosana Ferrati, Dr. Graciela Canziani and Ing. Diego Ruiz Moreno
Group of Mathematical Ecology, National University of the Center
of Buenos Aires Province (UNCPBA)

The studies carried out by the company EVARSA (under an agreement with the EBY; see http://www.eby.org.ar/ecologia.html) and by the UNCPBA (within the framework of the INCO DC project; see http://www.unisi.it/wetland) characterize the Iberá marshes hydro-meteorologically and analyze the variables governing the superficial hydrology of same.

The studies differ in the analysis period of the main hydrometeorological variables considered for the balance carried out. The INCO study analyzed the data covering the period 1969-1999, in agreement with the record of hydrometric heights registered in Iberá lagoon, while the EVARSA study considered the period 1983-2000.

The studies are comparable in the period in which they overlap- August 1986 to May 1999- since a characterization of the hydrometeorological variables at a regional and local level was made, a hydric balance model was developed and the results were used to compare the variations in the water-level of the system recorded in Iberá lagoon.

The data used coincides for the pluviometric stations of Pellegrini (SERNAH[16]). For the meteorological stations of Ituzaingó (SMN) and Mercedes (INTA). For the measurement station of Paso Lucero (SERNAH).

The data used differs in the series of flows measured in the measurement station of Los Laureles (SERNAH 1). Such station was used in both studies to fill the series of flows calculated in Paso Lucero in the missing periods. The difference between the series of data used would be due to the fact that the Sub-secretariat does not have the monthly flow values for the months of January, March, April, September and November 1984, November 1989, November 1990 and March 1993 of neither of the stations mentioned.

The zero of the Iberá lagoon scale (set in 1968 by Agua y Energía Eléctrica) was checked by EVARSA and the results reported to the Subsecretariat in December

16 Data obtained by EVARSA for the Sub-secretariat of Hydric Resources (Secretariat of Natural Resources and Human Environment - SERNAH); published in Estadística Hidrológica del Siglo XX (2000) and available on: http://www.mecon.gov.ar/hidricos/mapashidricos/est_act_corr.jpg

2001. The analysis summarizes the change in the zero of the scale by 42 cm, event which took place on 1 January 1984, going from the 61.054m level to the 60.63m level (gray line in Figure 1). It should be mentioned that in Book III, Volume 5 of the ICA-INCYTH study published in 1981, corresponding to the record of hydrometric data gathered manually, the zero of that scale is recorded at the 61.054 meters above sea level in one of the field worksheets, while in Volume I, main text of the Hydrology book, the zero of the scale is recorded at the 60.63 meters above sea level, this being a value that, according to EVARSA, is due to a change of the scale in 1984.

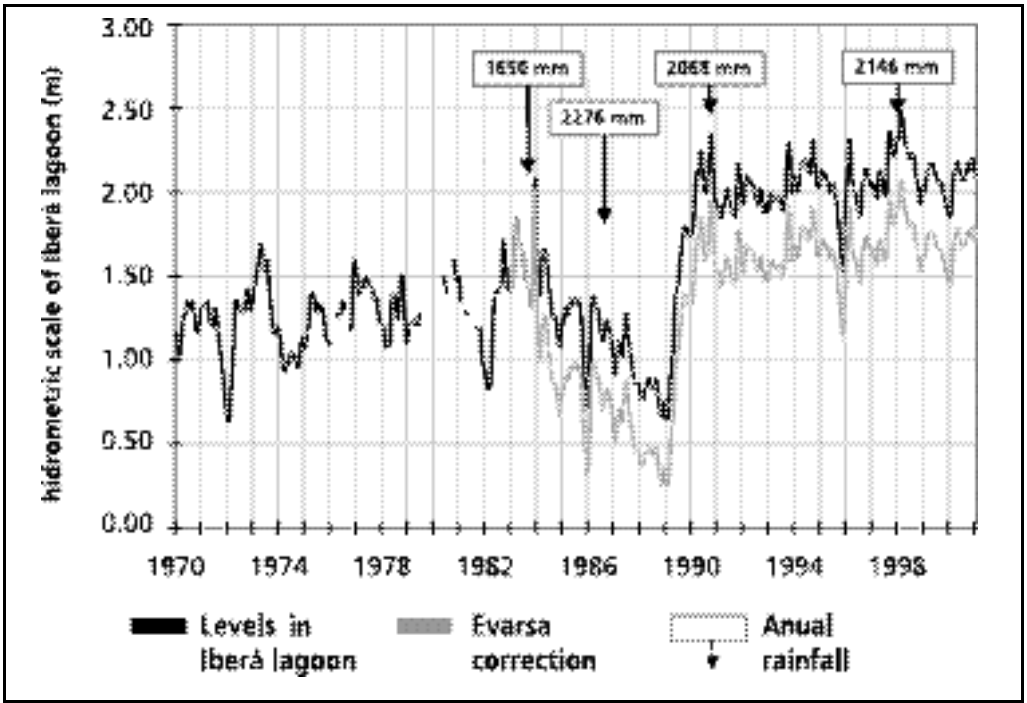

Figure 1: Hydrometric relative heights in Iberá lagoon.

The partial results obtained are similar as to the annual and monthly rainfall values calculated for the watershed in the period 1986-1999, and as to the monthly flow values calculated in Paso Lucero and Los Laureles, not in the months above mentioned.

The partial results obtained are dissimilar as to the monthly evapotranspiration values. Although the method used was the same, the stations considered and the areal ponderation algorithm were different. The values obtained by EVARSA are higher by 20% than the ones obtained by INCO. The results obtained by other

studies carried out in the province and the volumetric analysis developed at a regional scale by INCO for the decade 1970-1979 (Table 1) justify the correction of the algorithm with a 20% increase in the monthly evapotranspiration values calculated by INCO.

Table 1:
Accumulated values of rainfall, discharged volume and evapotranspiration per decade

Period	Rainfall (mm)	Discharge* (hm^3)	Evapotrans-piration (*) (mm)	Balance (hm^3)	Corrected Evapotrans.* (mm)	Balance (hm^3)
1970 - 1979	15,396	49,700 (23%)	9,950 (65%)	26,025	11,740 (76%)	1130
1980 - 1989	16,723	77,510 (33%)	10,158 (61%)	13740	11,986 (72%)	-11,670
1990 - 1999	15,560	75,131 (35%)	10,198 (66%)	-608	12,034 (77%)	-26,123

(*) percentage of the variable considered in connection with rainfall in the period.

The conclusions are contradictory. According to EVARSA, the balance of the atmospheric variables and the discharged flow accounts for the abrupt increase in water-level in 1989-1990. INCO, however, argues that there is a clear imbalance which points to the hypothesis of an underground inflow.

The definition of the initial conditions and of the hypothesis outlines is a key factor in this type of analyses. INCO uses a series of data as from 1969, which clearly allows distinguishing the dramatic change in the average level as from 1990 and observe the evolution in the dynamics of the system in response to the variations in rainfall and the maximum flow rates of the Paraná river. EVARSA bases its analysis on the series of data as from 1983, when the first important "El Niño" event took place and the system recorded one of its most important floods. The results so obtained lead to the belief that as from 1983 the system would be suffering a dry phase (when it was in fact regaining its average levels of the '70s) and then, when the level increased in 1989-90, the system would be "recovering" its historic level. The change in the zero of the scale in January 1984 contributes to the perception of a "recovery" in the system.

On the other hand, the distorage period obtained in the hydric balance carried out by EVARSA between 1986 and 1989 does not coincide with the conclusion related to the significance of rainfall in the system, since the rainfall recorded in the watershed in 1986 was only level with the devastating "El Niño" event in 1998. The values in Table 2 show the irregular behavior of the system in that period.

EVARSA makes use of satellite images to determine submerged areas and carry out comparative studies of the Iberá marshes. However, the methodology and algorithms used are not explained[17].

Table 2:
Annual rainfall values of the watershed (hydrologic year March-February), storage being expressed as the difference between the inflow through rainfall and the outflows through evapotranspiration and flow discharged in the period, and absolute difference (between the extremes of the period) of the water-level measured in the Iberá marshes.

Year	Rainfall (mm)	Storage (hm^3)	Level Variations (cm)
1986 - 1987	2276	- 4490	- 44
1987 - 1988	1663	- 508	- 30
1988 - 1989	1023	- 733	- 12
1989 - 1990	1520	4500	100
1990 - 1991	2068	5439	- 3

17 The satellite images are not photographs, but the graphic result in "false color" of the digital processing of frequency spectra emitted from the ground and captured by a remote sensor. Said processing requires the use of a variety of algorithms to make calculations, filterings and compositions, and the quality of the result obtained depends on the right choice of said algorithms.)

Appendix II

Considerations on the Institutional Report drawn up by the People's Ombudsman: "Yacyretá and the Iberá System. Alleged relationship bewteen the behavior of the Iberá System and the Yacyretá Dam" (June 2002)

Dr. Juan Rodrigo Walsh, Fundación Ambiente y Recursos Naturales (FARN)

Following the proceedings started by the Sub-secretariat of Environmental Management and Policy, in June 2002 the People's Ombudsman drew up an Institutional Report on the problems connected with the seepage between Yacyretá and the Iberá marshes[18].

Said Institutional Report deals with the problem from two different perspectives: one, of a legal-institutional nature, and the other, related to the hydrologic hypotheses and the alleged influence of the dam (and the increase in its level to reach the maximum design level) on the Iberá system. As regards the latter, the Report analyzes the technical measures adopted by the EBY to identify any possible negative effects of the dam on the marshes.

The considerations to be pointed out are as follows:

Institutional aspects

1)The EBY as an international entity

The Report emphasizes the nature of the EBY as an artificial person within public international law, as originated in the Agreements entered into by Argentina and Paraguay (Report p.12). As an entity with an international legal capacity, and according to the Report produced by the People's Ombudsman, the EBY would enjoy a sort of "immunity" with respect to the national legal system. The legal status of Yacyretá is discussed on page 13, Item IV.b ("Other considerations"), and it is argued that the Constitution amended in 1994 states the supremacy of international law over national law. This is the support used in the Report to point out that the agreement entered into by the EBY and the Secretariat of Natural Resources and Environment on 23 January 1995 vests advisory powers in the latter, without this implying that said powers are subject to the regulatory powers of the national entity, since they would be excluded by reason of the inter-

18 The People's Ombudsman, Institutional Report "Yacyretá y el Sistema Iberá: Presunta relación entre el comportamiento del sistema Iberá y el Embalse Yacyretá", Buenos Aires, June 2002. Recorded under number 12.027/00 (SSOyPA).

national agreements which gave rise to the hydroelectrical complex.
The binational nature of the EBY and its origins under international law cannot be ignored. However, it should not be ignored either that the interpretation of legal regulations as a whole should be in harmonious agreement with the rest of the constitutional legislation. In other words, even when it is subject to public international law as regards its specific subject matter, the EBY must comply with the rest of the normative constitutional structure, such as Section 41 of the National Constitution.
Failure to comply with the above would imply the *contrario sensu* establishment of a virtual system of exemption from the duty to remedy environmental damage set forth by Section 41. Should this reasoning be followed until the last consequences, we would come to absolutely incongruous conclusions, such as the lack of supervision and control by the State over the activities carried out and the environmental impacts produced by the EBY. Any damage caused by the action of the EBY would have no supervision of the administrative and judicial authorities, in a sort of "diplomatic immunity"difficult to reconcile with our constitutional body of laws. The constitutional supremacy of international law would be paradoxically validating a violation of the Constitution itself, being this inconsistent with the logical congruity that must accompany the legal system as a whole.
Moreover, in their interpretation of Section XIX of the Yacyretá Treaty, ratified by Law No. 20646, the courts have established that each of the parties shall apply its own legislation *"taking account of the provisions set forth in the Treaty"*, thus rendering the national legislation of each of the Parties applicable to the EBY, regardless of its nature as a binational entity.[19]

2) Need for dispute-solving institutional mechanisms

The Report acknowledges the insufficiency of proper institutional mechanisms for dispute-solving. This is a reality, acknowledged by financing multilateral agencies and the Binational Entity itself. There is no doubt that the historical context in which Argentina and Paraguay entered into the Treaty which gave rise to the Yacyretá works was very different from the present one.
In the '70s, the establishment of institutions aimed at the effective participation of citizens in the adoption of decisions with a high geopolitical content (such as Yacyretá had at the time) was not a high priority for the countries entering into the Treaty and the subsequent bilateral agreements which

19 See Lima, Juan y Vieito Ferreiro, Mabel, "El Amparo por Mora y su aplicación al ámbito de los contratos" (with special reference to the Yacyretá Binational Entity), La Ley (T. 1997-B, p. 375).

established the legal framework of the hydroelectrical work.
Item IV d) of the Report refers to this institutional gap and recommends that the dispute-solving body *"...should be technically competent, politically neutral and independent of any interest group related to the matters at issue..."*.
However, in the preceding paragraph, Item IV c) states that the EBY is not subject to customary controls by virtue of the supremacy of international law above discussed.
It is clear that there is an essential flaw in these arguments. If according to the People´s Ombudsman, the EBY is not subject to the supervision of the national environmental authorities, what then would be the need for a solving-dispute mechanism? By definition, any dispute-solving mechanism implies submitting oneself to the decision and jurisdiction of an independent authority empowered to adopt binding decisions, as it is the case of a judicial body[20].
Apart from the advantages of an Environmental Program of a participative nature to legitimate and agree on economic decisions, supported by the advice of entities such as the Secretariat of Natural Resources and Human Environment (IV a, p.13), it is clear that the lack of legal channels for the assessment of these projects and the settlement of disputes is a flaw that will undoubtedly demand future legislative remedies.

The hydrologic hypothesis

The Report rightly points out, in our opinion, the importance of the Precautionary Principle in environmental matters characterized by uncertainty (p.16). After describing the technical background and the studies carried out to determine the interaction between Yacyretá and the Iberá Marshes, the Report acknowledges the existence of different positions and opinions. For this reason, the Report supports the criterion that further research should be done.
In referring to the Panel of Experts and the studies carried out by Lotti & Associati and Harza & Consorciados, the Report arrives at a conclusion of the Panel of Experts that does not seem to have an actual support in the respective technical reports. On page 11, the Report quotes one of the conclusions of the Panel *"...from the Information analyzed it can be inferred that at present the seepage, if any, would have no effects of significance on the Iberá Marshes, and, in the event it took place, said effects could be quicklyand effectively mitigated or eliminated by means of conventional technology and in the short term."*

20 In the case of the EBY, this being an entity with legal capacity under international law, and the interpretation of an International Treaty being a sub judice matter, the Supreme Court of Justice would have jurisdiction over the case.

This statement is categorical enough and its implications would merit an analysis much deeper than the one made in the Report. In our opinion, this conclusion deserves a series of observations or questions which are not clear in the Report. How will the effects of the seepage be quickly mitigated or eliminated by means of "conventional technology"? How can they conclude, without having studied the matter in detail, that the seepage would have no effects of significance?

Conclusions

To sum up, the Report is a well-documented description of the technical background referred to the seepage problem, without examining its contents in depth. From the legal point of view, apart from pointing out the need for a dispute-solving mechanism, it fails to make a deep examination of the relationship between jurisdictional capacities and authorities in the light of the 1994 constitutional amendment, taking into consideration the particular nature of the EBY as an entity subject to public international law. Likewise, little value is attached to Section 41 of the amended Constitution and the need to comtemplate, within that context, the possible damage to the ecosystem of Iberá which might be caused by the dam operating at its maximum design level.

Appendix III

Critical Revision of the Proposals for the Study of the Seepage of Water between the Yacyretá Lake and the Iberá Marshes

Lic. Adolfo Fulquet, Sociedad Rural de Ituzaingó (Corrientes)
Lic. José Luis Angeleri, Cuenca del Batel Batelito (Corrientes)

Report of Consulting firm Lotti & Associati: It is the first report which, by means of a simulation of the regional underground flow, seeks to predetermine the behavior of the underground hydric resources in connection with the variation in level in Yacyretá lake. Hypotheses on the transmissibility of the aquifers are drawn and the possible environmental impacts of the aquifers related to the rise in the level of the lake (75 to 83 meters above sea level) are assessed. The report considers the basalt underlying Yacyretá lake impermeable.

Report of the Corrientes Water and Environment Institute (Instituto Correntino del Agua y el Ambiente): It proposes the study of the possible underground beds which would allow communication between Yacyretá lake and the Iberá Marshes, by means of studies assessing the magnitude of the seepage. It considers necessary to identify the area causing the possible seepage. While it points out the need to determine the overload effect of each aquifer unit on granular sediments and basaltic rock, it concentrates on the study of the granular material.

Panel of Experts of the Yacyretá Binational Entity: The participation of environmental bodies in order to preserve the Iberá Ecosystem was channeled through this Panel. This fact has rendered the assessment and follow-up of the seepage problem more transparent. The Panel of Experts has considered that the seepage from Yacyretá to Iberá has no effects of significance on the marshes. It argues that in the event it took place, its effects could be quickly mitigated. Its analyses center exclusively on the granular soils located over the underlying basalt.

Report of Consulting firm Harza: This report does not propose an integral hydrogeological study. Its area of study is limited to a small section in the contact area between Yacyretá lake and the Iberá Marshes. It emphasizes the importance of developing a superficial monitoring plan in some lagoons within Iberá, and of sup-

plementing the monitoring network used until the date when the report was drawn up. Unconsolidated sediments are the only matter of study in the document. The basalt permeability is considered secondarily since it is assumed to be completely impermeable.

Report of the Sub-secretariat of Hydric Resources of the Argentine Nation (Secretaría de Recursos Hídricos de la Nación): This proposal is based on a regional geological and hydrogeological analysis of the dynamics of possible subsuperficial inflows towards the Iberá System and aims at obtaining a definition of the area of influence of these phenomena. The hydrogeological research is limited to the "ceiling" of basaltic rock.

Report of ex Senator Romero Feris: This report points out the need to thoroughly define the processes and structures which permit the inflow of underground water into the Iberá. It proposes an assessment of the extent of the economic, ecological and social damage produced, and points out the importance of defining structural and non-structural measures to mitigate the damage. While this proposal is an original contribution as regards the reference terms necessary to assess the magnitude of the seepage, it has not been submitted officially.

Report of Dr. Miguel Auge (IADB): This is an audit entrusted by the Inter-American Development Bank. It provides a quick understanding of the problem taking place between Yacyretá lake and the Iberá Marshes, since it carries out a survey of available background. It includes a proposal of geological works especially connected with the hydrogeological problems of the loose sediments, but it fails to cover the basaltic rock.

			a)	b)	c)	d)
PROPOSALS			Lahy & Associati	ICAA	SRT Panel of Experts	SRT Panel of Experts (supplementary report)
Main objective (purpose searched for in:			Sedimentary cover-wrapping	Sedimentary cover-wrapping (1)		Sedimentary cover-wrapping
Drillings in:		Soils	Yes	Yes		Yes
		Rock		Yes, partial (EC no)		
Number of stations or probes (if indicated)			1.200 m	Not indicated		Not indicated
Analysis of satellite images						
Study of paleo-environments			Yes	Yes		
Geophysical studies through:	Refraction Seismic / cross hole		Yes / not included	Yes / not included		
	Geoelectrical profiles:	Vertical Electrical Probe (VEP)		Yes		Yes
		Sinusoidal device		Yes		
	Spontaneous Potential (SP), Resistivity and natural Gamma Gamma					Yes
Use of radioactive tracers						
Water studies on:	T°C			Yes		
	Salinity			Yes		Yes
	pH			Yes		Yes
	Conductivity			Yes		Yes
Study type:	Leakage / Lugeon			Yes / Yes		Yes
	Pumping		Yes	Yes		Yes
Design of phreatimetric water piezometric networks			Yes	Yes	Yes	Yes
Placement of hydrometric scale: in the basin						Yes
Study of hydraulic features in sub-superficial clays				Yes		
Simulation models			Yes	Yes	Yes	Yes
Time of performance (in months)				12		18

	e)	f)	g)	h)
PROPOSALS	Hugo & Consultants - CEDY	Subsecretaría Recursos Hídricos	Romero Seis, A. (Ex Senador)	Auge, M. Subsecretaría BID
Main objective / Seepage searched for in:	Sedimentary cover mapping (1)	Sedimentary cover mapping	Sedimentary cover mapping (1)	Sedimentary cover mapping (1)
Drillings in: Soils	Yes	Yes	Yes	Yes
Drillings in: Rock	Yes, partial (50 m)		Yes, partial (52 m)	Yes, partial (30 m)
Number of meters or probes (if indicated)	9 probes	Not indicated	Not indicated	9 probes
Analysis of satellite images		Yes	Yes	
Study of paleo watercourses			Yes	Yes
Geophysical studies through: Refraction Seismic / cross-hole	Refraction seismic for paleo-watercourses / No		Yes / not included	Refraction seismic for paleo-watercourses / No
Geophysical studies through: Geoelectrical profiles: Vertical Electrical Probe (VEP)		Yes	Yes	
Geophysical studies through: Geoelectrical profiles: Wenner device			Yes	
Geophysical studies through: Spontaneous Potential (SP), Resistivity and natural Gamma-Gamma				
Use of radioactive tracers				
Water studies on: T °C		Yes	Yes	
Water studies on: Salinity		Yes	Yes	
Water studies on: pH		Yes	Yes	
Water studies on: Conductivity		Yes	Yes	
Trials type: Lefranc / Lugeon	Yes / Yes		Yes / Yes	Yes / Yes
Trials type: Pumping	Yes	Yes	Yes	Yes
Design of phreatimetric and/or piezometric networks		Yes	Yes	
Placement of hydrometric scales in the dam	Yes		Yes	Yes
Study of hydraulic fracturing in subsuperficial clays			Yes	Yes (2)
Simulation models	Yes	Yes	Yes	Yes
Time of performance (in months)		18	24	

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References:

a) C. Lotti & Asociatti S.p.A. 1999. Estudio hidrogeológico macroregional del área costanera del río Paraná en el tramo entre presa Yacyretá y el Aº Yabebiry. Informe final (septiembre 1999). 72 pp.

b) Instituto Correntino del Agua y el Ambiente (Lic. José Luis Angeleri). 2000. Documentación referida a la interrelación entre el lago de Yacyretá y los esteros del Iberá (julio 2000). 4 pp.

c) Panel de Expertos - EBY. 2000. Interrelación entre el Embalse de Yacyretá y el sistema del Iberá (agosto 2000). 10 pp.

d) Panel de Expertos - EBY. 2000. Plan de investigación hidrogeológica de la zona de posible trasvase y propuesta de monitoreo de aguas subterráneas (August 2000). 2 pp.

e) Harza & Consorciados - CIDY. 2001. Proyecto Yacyretá 11247 - I - 31.3.00: Plan de investigación y monitoreo. Interrelación entre el Embalse de Yacyretá y los esteros del Iberá (March 2001).

f) Subsecretaría de Recursos Hídricos. 2001. Estudio hidrológico del Sistema Iberá. Determinación de la eventual influencia de los trasvases desde el Embalse de Yacyretá (July 2001). 4 pp.

g) Romero Feris, A. (Ex Senador Nacional). 2001. Iniciativa sobre el trabajo realizado por Patrouilleau, R.; J. Herrero, M. Gómez y E. Lucesole: Evaluación del incremento del nivel hidrométrico de los esteros del Iberá e investigación de las causas e implicancias económicas, ecológicas y sociales (August 2001). 8 pp.

h) Auge, M. 2001. Interrelación Embalse Yacyretá - Sistema del Iberá. Evaluación de la información existente y propuesta de nuevas investigaciones (September 2001). 20 pp.