ACTIONS TO SAFEGUARD BIODIVERSITY DURING THE BUILDING OF THE ITAIPU BINACIONAL HYDROELECTRIC PLANT

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Introduction

Brazil is one of the most diverse countries in the world. It has a unique natural heritage which is expressed in its ecosystems, biomes, landscapes, and flora and fauna, as well as in its genetic resources, combining to form the country's common legacy (ZANIRATO, 2010). Although the Atlantic Rainforest biome has been massively devastated, it still shelters a significant part of Brazil's biological diversity, particularly in relation to flora, and it contains a high level of endemism. Despite the fact that there are no precise data on the biodiversity of plants, estimates point to 20,000 species, that is, between 33% and 36% of the species in the country. Of these, 50% are endemic vascular plants (CAPOBIANCO, 2002).

The same could be said in relation to the fauna: of the 202 animal species considered to be in danger of extinction in the country, 171 are found in the Atlantic Rainforest, of which 88 are endemic birds (idem).

The building of the Itaipu hydroelectric plant is considered one of a number of events which contributed to the disappearance of the Atlantic Rainforest flora and fauna. The creation of the 1350 km^2 reservoir, the disappearance of waterfalls, rapids and weirs and the flooding of forests and agricultural land are considered exceptional events from the point of view of human intervention in the landscape, the impact of which has not yet been fully assessed.

With a view to gaining a greater understanding of some aspects of this process, our objective is to examine the plans drawn up by the Itaipu Binacional company during the process of building the reservoir. We present the conjuncture at the time the plans were made and actions were developed. Subsequently, we analyze the guidelines which served as a reference for the development of an environmental diagnosis and for setting

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up a flora and fauna inventory, and we make a review of the programs and actions based on this knowledge. In our final considerations we examine how the activities developed to safeguard the biodiversity identified were understood at the time.

The building of the hydroelectric plant, conjuncture and planning

The Paraná river, formed by the confluence of the Paranaíba and Grande rivers, flows in a south-easterly direction and forms a natural border between Brazil and Paraguay. A few kilometres downstream, outside Brazil's territory, the river bed is shared between Paraguay and Argentina.

The first studies in Brazil on using the waters of the Paraná river for energy production were conducted in the 1950s during the government of Juscelino Kubitschek. At that time the concern was to "grow fifty years in five". Projects were presented at the start of Jânio Quadros' government to increase energy generation which foresaw the building of dams along the river (GERMANI, 2003).

The plan proposed in 1961 did not envisage the use of cross-border waters and recommended that the river be diverted upstream from the Paraguayan border. A second plan produced in 1962 also foresaw an exclusively Brazilian hydroelectric plant, without the need to submerge the Sete Quedas falls. It was Argentina, however, which proposed the building of a plant in partnership with Paraguay, the Corpus Plant. Within a context of geopolitical disputes and vying for influence in South America, in 1965, already under the military regime, the Brazilian government joined forces with the Paraguayan government (MONIZ BANDEIRA, 1987, GERMANI, 2003). The Brazilian government convinced Paraguay that it should be its preferential partner, thus crushing Argentina's intentions. The agreement meant "the concretization of the Brazilian geo-political hegemonic project for the River Plate region" (SILVA, 2006, p. 80).

In 1966, under the command of the military State, an official document known as the "Ata das Cataratas" was signed, in which the building of the hydroelectric plant was agreed. This agreement meant that the Paraná River would be jointly exploited by Brazil and Paraguay. The conditions of the agreement were defined by the establishment of the Brazilian-Paraguayan Technical Commission and in 1970 a Cooperation Agreement was signed between the Brazilian electricity company - Centrais Elétricas Brasileiras S.A - ELETROBRAS - and the Paraguayan company, Administración Nacional de Eletricidad - ANDE. For Paraguay the partnership signified the means to "develop joint programs with its neighbouring country, in compliance with the "export corridor" policy (SILVA, 2006, p. 98).

The Itaipu Treaty was signed by the Brazilian and the Paraguayan governments in 1973, defining the terms of the venture. Itaipu Binacional was set up as an international company to promote the hydroelectric exploitation of part of the Paraná River from and including the Sete Quedas Falls, nowadays no longer in existence, to the mouth of the Iguaçu River, seventeen kilometres from the Argentine border.

The Sete Quedas Falls comprised seven large falls on the Paraná river on the border between Brazil and Paraguay. The falls were part of the Sete Quedas National Park

created in 1961, a place of great scenic beauty. The flooding meant significant changes to the Park's landscape and the adulteration of its nature. Legal difficulties were resolved by the signing of Decree 86.071, on 4th June 1981, abolishing the national park.

Once the Treaty was signed, two building designs were presented. The first proposed the construction of a single barrage with large energy generation potential, given the name of Itaipu. The second proposal foresaw the building of two barrages, further apart from each other, resulting in a smaller lake. The first proposal was chosen and the building of what became known as the "largest hydroelectric plant in the world at the time it was started. Itaipu would be capable of generating 12.6 million kilowatts, which could be incremented to 14 million. The electricity generated was to be equally shared between Brazil and Paraguay" (MAZZAROLLO, 2003, p.14).

Itaipu Binacional was charged with supervising the building of the hydroelectric plant which was protected "by national security legislation under specific laws, directly under the auspices of the Federal Government" (ANDERSEN, 2009, p. 8).

The construction site was set up in 1974 and the building of the diverting canal started in 1975. The canal was ready in 1978, and in June 1981, a Federal Decree abolished the Sete Quedas National Park. A year later, the members of a small environmental movement, known as Adeus Sete Quedas [Good-bye Sete Quedas], gathered inside the area to be flooded to protest against the Itaipu hydroelectric plant. (ALONSO, COSTA e MACIEL, 2007). In 1982 the floodgates were shut to create the reservoir.

The level of the waters rose to over 100 metres in 14 days and reached the volume required for energy production. The lake which enabled the Itaipu Hydroelectric Plant to operate was thus ready.

The size of the project is reflected in the amount of materials employed. The volume of concrete used "could have built 210 stadia the size of the Maracanã or a residential complex to house four million people. The quantity of iron and steel could have erected 880 Eiffel Towers" (SANTOS, 2006, p.35), "6,657,396 cubic metres of concrete" and approximately "17,973,562 cubic metres of iron and rock" were used (NOSSO TEMPO, 10 to 17 June 1981, p. 16-17).

The lake flooded an area of 1460 km^2 between Brazil and Paraguay and submerged forests, agricultural areas and archaeological sites. Approximately 40,000 people had to be removed from the Brazilian side of the river and 25,000 from the Paraguayan (PINAZZO, 1996, ANDERSEN, 2008).

The deforestation necessary to carry out the building work and the drastic changes in the river's water regime transformed it into an enormous lake of stagnant waters. Despite mitigation plans, the impact on the flora and fauna was significant.

In order to comprehend these events, it is important to analyze how the environment was understood at the time.

First of all, it is essential to consider that when the Itaipu Plant was built environmental concerns were just emerging in Brazil, although at the international level, some treaties had already been signed.

In order to understand how the Brazilian Government viewed environmental issues, it is worth remembering that Costa Cavalcante - a director of Itaipu - was one

of the representatives sent by Brazil to the Stockholm Conference in 1972 to discuss environmental degradation due to water, air and soil pollution. Speaking on behalf of Brazil, the then Minister Costa Cavalcante positioned himself against measures to slow down development, considered to be the root of environmental problems. According to him, Brazil had "to develop first and pay the costs of pollution later" (GOLDENBERG, 1997, p. 7).

This attitude reveals how the military government regarded any measures to control development, particularly at a time when the priority was drafting policies whose main objective was to grow the economy to its maximum potential. "Environmental restrictions conflicted with development strategies which were specifically based on the implementation of polluting industries, such as the petrochemical industry, and the development of large energy and mineral projects" (JACOBI, 2003, p.3). Furthermore, the emergent environmental movement in Brazil was repressed by the military government (VIOLA, 1987).

This is therefore the context in which the Itaipu Binacional developed plans to reduce the impacts caused by the building of the hydroelectric plant, including the Basic Plan for the Conservation of the Environment in 1975.

The Basic Plan for the Conservation of the Environment

This Plan was first drafted in 1972 when the Brazilian-Paraguayan Mixed Technical Commission produced a report entitled "Recognizing the Ecological Effects of the Itaipu Project".

> It highlighted the possible occurrence of changes to the fauna, flora, climate and sanitary conditions of the reservoir area. It also stressed the existence of archaeological remains and established which measures should be taken to prevent or minimize negative impacts on the one hand and exploit positive impacts on the other (MIRANDA, 2008, p. 25).

Concerns at the time already reflected a need to "reduce the negative effects" which were likely to occur.

Once the construction of the canal started, Itaipu Binacional produced a document which became known as the "Basic Plan for the Conservation of the Environment". The guidelines for action were described in the six chapters of the report which also provided information on the character of the region, the potential environmental impacts resulting from the venture and the measures and programs which should be carried out to "reduce impacts". The main concern was to "mitigate the environmental impact of the barrage, whilst allowing for the ecological control of consequent effects" (ITAIPU BINACIONAL, 1975, p.1). This meant remedying, as far as possible, the effects of implementing the hydroelectric plant and quashing any criticisms raised by the social sectors concerned with the environment.

In order to do so, the following guidelines had to be implemented, in stages:

> A) List environmental problems which directly impacted on the plant's operation, including those caused by the building works;
> B) Identify specific projects to protect the plant and the region's environment, so as to attenuate consequent environmental impact;
> C) Establish general plans for the multiple use of the reservoir together with a scheme for its respective institutional integration;
> D) Propose a monitoring-administrative structure within ITAIPU and produce an operational budget (ITAIPU BINACIONAL, 1975, p.1 and 2).

The main effects of the construction were identified as the transformation of 170km of the Paraná river and the submersion of the Sete Quedas Fall. Secondary effects were the destruction of forest and agricultural land, the reduction of animal habitats, and the flooding of unknown mineral deposits and areas of archaeological interest.

The Basic Plan recognized that the region was covered in forest which was the habitat of rare animals, including endemic and endangered species. In order to create the lake, it was necessary to remove the forest cover and to consider the animal species that needed protection, in particular those threatened by extinction. It was, therefore, necessary to produce inventories of the region's flora, fauna and ichthyofauna, as well as an archaeological inventory (ITAIPU BINACIONAL, 1975, p.1 and 2).

The Forest Inventory had to consider the forest population, identifying the fruit species of interest to the fauna, as well as native and exotic forest species. It also had to draw up forest management, nursery and reforestation plans. Furthermore, a project for the exploitation of the forest had to be produced, distinguishing the trees with industrial potential from those which would be burned before the flooding of the lake.

The aim of the fauna inventory was to distinguish the more common terrestrial, amphibious and aquatic species from the rarer endemic and threatened species, collect samples for their exhibition in a natural history museum and propose measures to protect rare and threatened species. In addition, a plan had to be drawn up which included managing the fauna and capturing animals, as well as reforesting and conserving areas such as biological refuges so as to prevent animals from invading urban centres. There were also plans for a "hospital" for wounded animals.

This Basic Plan provided the guidelines to produce the forest and fauna inventories.

The forest inventory and management projects

According to the guidelines of the Basic Plan, the inventory had to identify the forest population and highlight native and exotic forest species, as well as develop forest management projects. Another aim was to produce a plan for exploiting and assessing trees which could have a commercial potential (ITAIPU BINACIONAL, 1975).

The forest inventory was drawn up in 1978 by the Forestry School, part of the Federal University of Paraná, in order to "diagnose the state of the forests in the region".

An area of 123,561.82 hectares on the left side (the Brazilian side) of the reservoir was selected, despite the fact that the area affected by the project encompassed only 94,429.18 hectares. The additional extension was due to the fact that an area of forest not affected by flooding needed to remain standing in order to protect lakeside areas from erosion, also providing a sanctuary for the animals from the flooded areas. The sites which were affected by the construction works would be reforested (ITAIPU BINACIONAL, 1978 a, p. 2).

The analysis of aerial photographs was the method used for this assessment. This was considered to be sufficient to prove that 52.8% of the region to be flooded was covered by forests; 24% of this area consisted of trees considered appropriate for commercial exploitation, as their trunks measured between 3 and 12 metres. Based on the analysis of aerial photographs, three types of forests were identified: dense forest, dense forest under exploitation, exploited/secondary forest, as well as other areas, namely, uncultivated/grassland or exploited and reforestation areas (ITAIPU BINACIONAL, 1978 a).

The first area was determined due to the uniformity of its high canopy, a sign it had not yet been exploited; dense forest under exploitation was identified as places which had already been affected by extra-environmental factors, particularly through the selection of species for furniture-making by the logging industry. The third type of forest is described as low forest with little commercial value, a result of previous exploitation. The fourth area suffered more intense exploitation and resulted in uncultivated grasslands or areas used for cultivating soya, wheat, corn and other crops. Lastly, there was also an area of reforestation, identified by the homogeneity of its volumetric potential and uniform tree distribution (ITAIPU BINACIONAL, 1978d).

Among the forest areas, only the first three types were considered significant: dense forest, dense forest under exploitation and exploited/secondary forest.

The importance of conserving forests outside areas to be flooded was highlighted, together with the commercial value of wood to be extracted from the flooding areas. The commercial exploitation of trees was also considered in the inventory, to be used to manufacture parquets, laminates, boards, matches and boxes. Trees could also be employed in the civil and naval construction industries and in sawmills, carpentries and joineries. Other uses of wood included charcoal provision, furniture-making, manufacture of cellulose and mechanical pulp, and the food industry (ITAIPU BINACIONAL, 1978, b).

Trees identified as having the greatest commercial value were Angico vermelho *(Parapiptadenia rigida)*, used in sawmills and carpentries; Cabriúva *(Myrocarpus frondosus)* employed in the manufacture of parquets and in civil construction, as well as in sawmills and carpentries; Canela amarela *(Nectandra sp.)*; Canela preta *(Nectandra megapotamica)*; Canjarana *(Cabralea canjerana)*; Cedro *(Cedrela fissilis)*; Ipê Preto *(Tabebuia avellanedae)*; Pau Marfim *(Balfourodedron riedelianum)*; Peroba Rosa *(Aspidosperma polyneuron)*; Louro *(Cordia trichotoma)* and Canafístula *(Peltophorum dubium)* (ITAIPU BINACIONAL, 1978 b, p. 08).

Subsequently, the future of the trees with no commercial value was assessed and a number of alternatives were put forward.

First, the possibility of flooding the area without removing the forest cover. This would be the simplest option, since the only action needed to be taken was the expro-

priation of the land. However, some consideration was given to the consequences of not removing the forest cover before flooding, including its impact on the quality of the water, with a reduction in oxygen levels due to the large quantity of decomposing organic matter. The rotting of this biomass would affect aquatic life. It was not considered prudent to leave 4.3 million cubic metres of forest to rot. It was also noted that as well as impacting on oxygen levels this option would negatively affect navigation and tourism on the lake, given that river transport would need to address the dangers presented by submersed trees.

A second alternative foresaw the selection of trees with an economic value whilst leaving the remainder to be submersed. This would result in the same environmental impacts but with lower costs, given that it would not be necessary to clear the land beforehand and that the extracted wood could be commercialized. However, it was observed in the inventory that: "the selective exploitation of the forest, without clearance, would present serious ecological, security, aesthetic and leisure problems. It is therefore not advisable" (ITAIPU BINACIONAL, 1978 b, p. 08).

According to the Inventory, the final option was the total clearance of the area, initially involving the removal of economically valuable trees and then burning the remainder. This was considered the best alternative, taking into account economic, ecological, security, and aesthetic and leisure aspects. Furthermore, it had the benefit of allowing landowners to use the land for agricultural purposes for a period of 1 to 3 years previous to it being submersed. Given that soils were covered in virgin forest, there was no need for fertilizers, making this activity extremely profitable (ITAIPU BINACIONAL, 1978 b, p.8).

The Basic Plan also envisaged a security green belt around the lake, requiring lakeside areas to be reforested and extending riparian woodland.

The botanist Gert Hatscbach, from the state of Paraná, was contracted to collect and identify species and create a herbarium. His work resulted in a catalogue of forest species which was delivered to the company, with a copy to the Municipal Botanical Museum of Curitiba. The catalogue identified many species, some of which were rare or previously unknown in the Paraná flora, such as the pixirica grande (*Miconia jucunda* DC) and mata-calado (*Marsdenia sp)*. However, there were other species which could not be catalogued due to lack of material or because they had previously never been found - but which could perhaps be identified in the future - as well as countless toxic species which were only known by the settlers of this region (ITAIPU BINACIONAL, 1978 d).

The species recommended for the green belt and for reforestation purposes in general were mostly those which produced food for fish, birds and terrestrial animals. For example, açoita cavalo *(luehea divaricata)*, aguaí *(Chrysophyllum gonocarpum)*, angico vermelho *(Parapiptadenia rigida)*, ariticum *(Annona cacans)*, camboatá *(Matayba guyanensis)*, cabriúva *(Myrocarpus frondosus)*, canafístula *(Pelophorum dubium)*, canela preta *(Nectandra megapotamica)*, canjarana *(Cabralea canjerana)*, cedro-rosa *(Cedrela fissilis)*, coqueiro *(Arecastrum romanzoffianum)*, guabiroba *(Campomanesia guabiroba)*, guajuveira *(Patagonula americana)*, ingá *(Inga marginata)*, ipê *(Tabebuia avellanedae)*, jacaratiá – or mamão do mato – *(Jacaratia spinosa)*, louro *(Cordia trichotoma)*, maria-preta *(Diatenopterys sorbifolia)*, palmito (Euterpe edulis), pitanga *(Eugenia uniflora*), pau marfim *(Balfouroden-*

dron riedelianum) and peroba rosa *(Aspidosperma polyneuron)* (ITAIPU BINACIONAL, 1978 c, ITAIPU BINACIONAL, 1979).

The use of some exotic species such as pinus and eucalyptus was recommended because of their rapid growth, accelerating the attainment of expected outcomes.

The analysis of the inventory shows the document's intent in highlighting economically valuable species. This is why a number of attributes such as hardness, beauty, resistance and ease of handling are mentioned. This can be observed from the way trees are described in the inventory: the wood of the peroba rosa tree *(Aspidosperma polyneuron)* is very hard and dense, with regular fibres. It is easy to work with. These attributes make it into one of the most important trees in the south and east of Brazil, used in internal and external construction work, in carpentry and for making boards, beams, rafters, parquet flooring and staircases. The guamtabu *(Aspidosperma ramiflorum)* is a very tall, straight and hard-wooded tree which has many commercial uses, similar to peroba. Cabriuva *(Myrocarpus frondosus)* is a very resistant tree and therefore is frequently used for making luxury furniture and in exteriors. Canafístula *(Peltophorum dubium)* is a very straight and tall tree found in the states of Paraná, São Paulo and the southern regions of Minas Gerais. Its wood is very light in colour and it is often used for internal decoration. Alecrim *(Holocalyx glaziovii)* can reach between 10 and 15 metres in height and can measure 40 cm in diameter; its wood is hard and white and it is used in internal and external construction. Angico vermelho *(Parapiptadenia rígida)* is found throughout southern Brazil and is frequently used for making boards. Pau-marfim *(Balfourodendron riedelianum)* has whitish-yellowish or white wood and is used in joinery. Cedro rosa *(Cedrela fissilis)* can reach between 20 and 25 metres in height, its wood is reddish-yellow or red and it is frequently used in furniture-making, staircases, windows and internal decoration (ITAIPU BINACIONAL, 1978 d).

Descriptions constantly asserted the commercial value of the flora found in the Itaipu region. "In fact, the sale of commercial wood in barrage regions was only a modest source of income for electricity companies" (DEAN, 1997, p.311).

The document concluded with the following consideration:

> Although this region was discovered a long time ago, little is known about the characteristics of its forest cover. There is little information in the Brazilian literature on the makeup of these forests which have been gradually destroyed, giving way to soya and wheat production. Even less is known about their origins, ecological conditions and reproduction patterns. Information only exists about the most valuable types of wood (ITAIPU BINACIONAL, 1978 d, p. 21).

This observation expresses both the lack of knowledge about the region's forest and the predominating understanding of its most profitable uses. It also expresses some justification for the degradation already underway, exempting the company from losses for which they could not be made liable.

The Forest Inventory was produced according to the guidelines described in the Basic Plan and covers the identification of species, forest management considered appropriate for nurseries and reforestation, and the ways of exploiting economically valuable

tree species whilst distinguishing them from those that would be burned before flooding the lake.

The guidelines of the Basic Plan also established the procedures for dealing with the local fauna.

The Fauna Inventory and management plans

The Fauna inventory was drafted between 1977 and 1979. It was also drawn up by the Federal University of Paraná, according to the Basic Plan guidelines. The analysis was restricted to the right bank of the Paraná River (Paraguayan part), an area of vegetation largely covered by dense forests, sheltering a large quantity of animals.

The aim was to identify the common, rare, endemic and threatened terrestrial, amphibious and aquatic species, collect samples to be exhibited in the natural history museum and propose measures to protect rare and threatened species.

In relation to capture, the recommendations of the Basic Plan were to:

> – determine the appropriate means and equipment to remove the fauna from flooded areas;
> – plan animal reception refuges, preventing them from invading urban centres;
> – designate areas for large animals requiring more living space than that provided by the area surrounding the barrage;
> – plan a "hospital" for animals wounded during their removal from flooded areas (ITAIPU BINACIONAL, 1975, p.18).

Both day and night-time tracking and field studies, on foot and by car, were used to register the fauna. The aim was to identify animals to be captured and sent to biological reserves and other areas considered suitable, including zoos. Animals would be removed as and when they "felt threatened by the waters" (ITAIPU BINACIONAL, 1979, p. 133).

The inventory included "the recognition of rare and threatened species", as well as the "dietary habits of wild animals" and "the diagnosis of the illnesses and parasites affecting wild animals" (ITAIPU BINACIONAL, 1979, p. 132).

35 species of mammals belonging to 18 families and 9 orders were catalogued. Carnivores made up the largest group (31.42%).

Of the animals identified, the following predominated: nine-banded armadillos *(Dasypus novemcinctus)* (18.48 animals per Km^2) and agouties *(Dasyprocta paraguayensis)* (17.57 animals per Km^2). Less abundant animals included the giant otter *(Pteronura brasiliensis)*, pumas *(Puma concolor)*, jaguars *(Panthera onca)* and the tapir *(Tapirus terrestris)*. The populations for these animals were very small, at values lower than 0.05 per km^2 (ITAIPU BINACIONAL, 1979).

17 species of reptiles were registered, the most abundant were skinks *(Mambuya sp.)*, with an average of 65.5 animals per km^2.

The largest population of birds was found in the dense forest, with 129 species belonging to 54 families and 20 orders. These included the sungrebe *(Heliornis fulica)* –

the only species of this family in Latin America, found in isolated places; the scaled dove *(Scardafella squammata)* – found only during some periods of the year; the surucuá-de--barriga-amarela *(Trogon rufus)* – very scarce in the region; the saffron toucanet *(Baillonius bailloni)* – found in the south and south-eastern regions of Brazil and in Argentina; the swallow tanager *(Tersina viridis)* – only species of this family in Latin America; and the king vulture *(Sarcorhampus papa)* – found in isolated locations. 1,600 species of insects were recorded corresponding to 19 orders (ITAIPU BINACIONAL, 1979).

Once the diversity of species was recorded, dietary habits were analyzed, as many species would be monitored in biological refuges or be kept in the company's zoo. Knowledge of food habits would help to define the biological reserves and adapt them to the dietary needs of animals existing in or introduced to the area. In order to do so, a study of stomach contents and observation of food chosen by animals in the wild was conducted.

It was observed that 35.7% of birds fed on insects and 23.6% on grains and fruit, while 14% were aquatic birds, feeding on crustaceans, molluscs and fish.

Some mammals fed on shoots, leaves, roots and fruits, whilst other ate a wide range of animals such as rodents and birds.

Reptiles also presented a varied diet based on insects, birds' eggs, fruits, molluscs and detritus of rodents and birds (ITAIPU BINACIONAL, 1979).

According to the Basic Plan, the main illnesses affecting wild animals were also studied. This knowledge was considered necessary for planning medication and precautionary measures to prevent illnesses both during the capture period and inside biological reserves.

Once these studies were completed, the company concluded that "inside the area to be flooded, there is a variety of fauna in large numbers and they should be rescued". Nevertheless, they also claimed that species were found both within the flooded area and in areas to be preserved. Therefore, no species "will be directly threatened with extinction by the increase in water levels. However, the total population and the habitat of some species would decrease" (ITAIPU BINACIONAL, 1979, p. 141).

Actions to capture the animals began once the studies were completed. The company was aware that the creation of the lake would lead to a reduction in fauna. The company sought guidance from the São Paulo Zoological Park and the Instituto Butantã, based in São Paulo. These institutions had provided support to other companies in similar situations, such as during the construction of the Marimbondo, Salto Osório and Capivara hydroelectric plants in different parts of Brazil.

The Forestry Police and Itaipu staff were responsible for collecting the animals on the Brazilian side and received guidance from São Paulo technicians and officers, sent to the area to train local staff on how to carry out these tasks (ITAIPU BINACIONAL, 1979).

According to the company's documents, between the 13th October 1982 and 25th February 1983, the period in which the lake was created, countless animals were caught by the rescue teams inside the flooding area on both sides of the reservoir, including in the canopies of trees and on islands. Motor boats, cars, planes, helicopters and radio communication were used (ITAIPU BINACIONAL, 1987).

According to the company, 27,150 animals were rescued: 7,547 mammals, 1,848 birds, 12,081 reptiles and 5,674 arachnids. Most animals went to the refuges, with the

exception of the arachnids and poisonous snakes which were sent to the Instituto Butantã in São Paulo.

Refuges were located in the forests around the reservoir, in conservation or reforested areas. The Paraguayan refuges were Tati Yupi, Carapá and Maracaju (on the border) and the Itabó and Limoy reserves; In Brazil, there was the Bela Vista and Santa Helena refuges (ITAIPU BINACIONAL, 1987).

Rodents made up the largest number of mammals captured (1617 animals) followed by primates *(Cebus paraguayanus)* (1538 animals). The following rodents were saved: catitas *(Monodelphis brevicaudata)* (623), agouties *(Dasyprocta paraguayensis)* (588), cuícas *(Marmosa cinerea)* (537), gambás-sul-americano *(Didelphis azarae)* (448) and coatis *(Nasua nasua)* (439). Other mammals found in smaller numbers were *pacaranas (Dinomys branickii)* (1), grey brockets *(Mazama gouazoubira)* (4), greater grisons *(Galictis vittata)* (12), red brockets *(Mazama americana)* (14), crab-eating foxes *(Cerdocyon thous)* (15) and collared peccaries *(Tayassu tajacu)* (20). In addition, there were also oncillas *(Felis tigrina)* and domestic cats *(Felis cati)*, a total of seven animals.

The most common birds caught were inhambu-chitãs *(Crypturellus tataupa)* (449), white-feathered puffbirds *(Nystalus chacuru)* (312), smooth-billed anis *(Crotophaga ani)* (299), Guira Cuckoos *(Guira guira)* (275), spot-winged wood quails *(Odontophorus capueira)* (224) and squirrel cuckoos *(Piaya cayana)* (177). The following birds were less numerous: grey-necked wood rails *(Aramides cajanea)* (6), black vultures *(Coragyps atratus)* (7), Brazilian Teals *(Amazonetta brasiliensis)* (10), plumbeous kites *(Ictinia plumbea)* (24) and rusty-margined guams *(Penelope superdiliaris)* (65).

Of the 12,081 captured reptiles, 1253 were skinks *(Tupinambis teguixin)*, 371 salamanders *(Epichrates cenchria)* and 13 tortoises *(Geochelone carbonaria)*; the remainder were poisonous and non-poisonous snakes (ITAIPU BINACIONAL, 1987).

According to the company,

> the animals trapped in either temporary or permanent islands were rescued, some had tree and creeping habits. Other species were caught on floating trunks which served as life-saving barges and played a very important role (ITAIPU BINACIONAL, 1987, p. 132).

Although animals were captured when the waters rose and they sought refuge, the company considered their actions successful on both river banks because "most animals were good swimmers and saved themselves" (ITAIPU BINACIONAL, 1987, p.133).

In the conclusion, they were certain that they had identified species and developed a procedure for saving and managing the animals in the refuges, as well as having planned "hospitals" for wounded animals.

Environmental rhetoric within a developmentist context

There is no doubt that the reasons behind the actions developed by Itaipu Binacional were to simply remedy part of the problems caused by the implementation of

this venture. Indeed, "(...) environmental research was only conducted to comply with demands from Federal Government administrators and funders. They did not influence the pre-established decisions related to the engineering projects" (ROSS, 1999, p. 19).

The main reason for the existence of Itaipu Binacional was energy generation. Reducing the impacts of this venture was of secondary importance. This was evident in the Basic Plan for the Conservation of the Environment, which established in its guidelines that environmental impacts should be taken into account to ensure the successful operation of the plant.

Itaipu Binacional was very explicit in this respect:

> The main objective of the Itaipu project is to produce electricity. Therefore, an enormous amount of resources will be invested which should generate continuous dividends. Ensuring the continuity of these benefits is one of the important roles of forest cover, particularly, the protection of the hydroelectric dam against river basin erosion. It is possible that there will be a demand for additional benefits such as the production of wood, as a raw material, and the protection of fauna (ITAIPU BINACIONAL, 1978 d, p.1).

These were the principles that guided the development of the inventories and subsequent actions related to the flora and fauna.

Despite the fact that the forestry inventory might have identified the diversity of the flora, pointing to gaps in knowledge, the objective of the provisions laid down was valuing the commercial potential of timber extracted from flooded areas. Similarly, the purpose of clearing areas before the waters rose was to make better use of the trees and prevent deforested and flooded areas from having a negative impact on the performance of the reservoir.

This was what was set out in the documents, although things may not have in fact occurred as planned. According to information conveyed by the local media, during the flooding it was possible to see in many areas of the lake the "typical tree cemeteries which indicated that flooding occurred without prior clearance". A number of trees such as açoita cavalo, amoreira, angico, bambu, canafístula, canela, canjarana, cabriúva, guatambu, ingá and maria preta could be seen rotting (NOSSO TEMPO, 9 and 16/12/1982, p. 3).

The purpose of measures taken to reforest areas degraded by the building work, together with lakeside areas and riparian woodland was to "increase the security zone around the reservoir, forming a green belt" (ITAIPU BINACIONAL, 1978 c, p. 23). The concern in speeding up the formation of this belt explains the types of vegetation planted which included exotic and fast-growing species.

Pragmatism replaced supposed environmental concerns. In the inventory, it was observed that "there are few details about the flora make-up of these forests in Brazilian literature" (ITAIPU BINACIONAL, 1978 d, p.21). However, classification was based on existing knowledge of species. We can therefore presume that there were losses both relating to species already known about and to species which may have become extinct without there being enough time or interest in acknowledging their existence.

A similar situation can be observed in relation to the fauna. From the beginning the company stated that biological depredation in the region was already a factor previous to its venture, and the establishment of reserves was a way of "preventing the extinction of particular species which are threatened, not only by the barrage, but also by the predatory actions of man" (ITAIPU BINACIONAL, 1979, p. 127). References to earlier losses can be understood as a way of avoiding responsibility for destroying the remnant fauna. There was no concern for the preservation of samples representative of biodiversity, and its processes and patterns; rather, animals were merely rescued as they left the flooded areas.

Despite the way animals were captured, claims were made so as to express environmental concern. For example, the inventory enabled the acquisition of knowledge about the remaining wilderness in the territory and refuges, reserves and zoos were sites for protecting the animals saved by the venture.

It is known that the fragmentation of habitats can lead to a reduction in biodiversity. With regard to fauna, effects can be observed by the change in the heterogeneity of species and the abundance of populations which can either increase or decrease or even become totally extinct (OFFERMAN et al., 1995 and BRUNA et al., 2009).

Nevertheless, all the actions to "safeguard" the fauna and flora were defined as having an "incalculable value, not only for Binacional Itaipu itself and both the countries involved in this venture, but also for biological science" (ITAIPU BINACIONAL, 1979, p. 141).

The method employed for rescuing animals cannot be classified as adequate for safeguarding them, considering that they were captured as the waters rose. This meant that the animals had to use their own means to find refuge in places where they could be more easily captured than in their natural habitats. This procedure was criticized, for example, by Warren Dean: "they contracted wild life specialists to 'rescue' animals trapped by the rising waters - a photogenic but not very effective action" (DEAN, 1996, p. 316).

This resulted in losing animals which could not swim, with the young unprepared for the situation and litters covering the waters of the lake. Procedures were criticized by specialists, such as the biologist who gave an interview to a Foz do Iguaçu newspaper and stated that "most animals could not be rescued"... "approximately 80% of animals in the flooding region did not survive due to lack of technical training and adequate equipment to capture them". According to this biologist, lizards, armadillos, opossums, monkeys, frogs, wild dogs and wild cats were some of the animals seen in the muddy waters of the rising reservoir. Furthermore, birds' nests were trapped in the canopies of trees, such as "black and white anis, kites, great kiskadis and swallows". Not to mention the cases of migrating fish such as dorados and surubis, no longer able to spawn (NOSSO TEMPO, 9 and 16/12/1982, p. 3).

Similarly, it was mentioned that many dead and rotting animals were sighted in the bays formed by the reservoir (BOLETIM POEIRA, 1982).

The local press also stated that animals, particularly those which managed to leave the flooded areas by themselves, invaded the homes of local residents and ended up being killed. The Foz de Iguaçu paper went as far as estimating the loss of 70 species of mammals, 253 species of birds and 1,600 species of insects. According to this paper, approximately

70% may have perished in the waters (NOSSO TEMPO, 9 and 16/12/1982, p. 3).

Rescued animals did not meet a better fate. According to Warren Dean, the sites where animals were taken were "sad 'animal units' set up in 'refuges' on the banks of the lake - a total of 390 km² - less than 10% of the total flooded area" (DEAN, 1996, p.312). The concentration of animals in relocated areas may have disturbed the equilibrium and the dynamics of populations, both by the loss of individuals and the subdivision of populations (WILCOX and MURPHY, 1985).

These facts cannot be ignored or else we run the risk of incorporating the environmental rhetoric of the company which claimed to have adopted measures which had an "incalculable value", not only for the company and the two nations involved in the venture but for "all biological sciences" (ITAIPU BINACIONAL, 1979, p. 141).

Final considerations

An environmental activist, arrested because he was protesting against the building of Itaipu, declared at the time that the creation of the lake was "like a gust of wind sweeping everything in its way, leaving behind only marks. Devastating everything. By the end of 1982 the waters had swallowed the land and everything that remained on it" (MAZZAROLO, 2003, p. 04).

In fact the documents produced by Itaipu Binacional allow us to argue that there were significant changes to the region affected by the creation of the lake. There were losses in biodiversity, given that the reduction in the area had a direct impact on the number of remnant species (HARRIS, 1984).

However, the company did not take responsibility for these losses. Even five years after the lake was created, it continued to argue that the natural environment had already been profoundly altered prior to the construction of the plant and that it contributed toward the conservation of biodiversity with "one of the first initiatives for protecting the remnant fauna". The company stressed at the time that this only occurred because "the creation of the Itaipu Binacional reservoir resulted in the development of a program for rescuing the fauna which were sent to biological refuges". There may have been losses, the company added, but they were natural, given the lack of "either taxonomic studies or adequate bibliographic and representative collections in the country, necessary to identify a number of genus, especially rodents" (ITAIPU BINACIONAL, 1987, p. 137).

Even if we take into account the fact that at the time there was no obligation to conduct Environmental Impact Studies (EIS) and Environmental Impact Reports (EIRs), as these instruments were only made compulsory via the CONAMA [National Environmental Council] resolution in 1986, it cannot be claimed that the actions taken by Itaipu at the time were motivated by environmental concerns. As Ross highlights, actions sought to "meet the demands of the managers of federal bodies and funders" and remedy any damage which may have compromised the performance of the hydroelectric plant (1999, p. 19).

Despite the Itaipu Binacional discourses, their practices resulted in environmental problems which were not restricted to the flooded area, but also affected downstream and

surroundings areas, leading to changes in the dynamics of the river, the destruction and fragmentation of habitats and the disappearance of the Sete Quedas Falls.

Despite the fact that Itaipu Binacional discourses insisted that they had defended the environment since the beginnings of the hydroelectric plant, it could be claimed that the implementation of the plant meant choosing to sacrifice biodiversity in exchange for large-scale energy generation.

These discourses need to be de-constructed not only to reveal the serious environmental damage caused during the actual construction of the barrage, but also because Itaipu continued to be presented as a sustainable model of a hydroelectric plant, even by those who should never be singing from the same hymn sheet. For example, the former Minister for the Environment, Marina Silva, stated that Itaipu was a sustainable model for a hydroelectric plant (Gazeta Mercantil, 2004).

If there was a lack of studies on the local flora and fauna, as the inventories alleged, it cannot be forgotten that the waters that move the Itaipu turbines and generate energy for the country leave a bitter taste due to all the losses mentioned above. Today there are still many challenges related to mitigating the socio-environmental impacts of building hydroelectric plants and protecting the natural heritage of the country, especially in view of the fact that hydroelectricity remains the most sought after alternative for energy generation in Brazil.

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ACTIONS TO SAFEGUARD BIODIVERSITY DURING THE BUILDING OF THE ITAIPU BINACIONAL HYDROELECTRIC PLANT

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Abstract: This article discusses the plans and actions designed to safeguard the diversity of the flora and fauna present in the territory which was flooded to create the Itaipu Hydroelectric reservoir between Brazil and Paraguay. We analyze the guidelines developed by the company responsible for the work, which steered the development of fauna and flora inventories, within a developmentist context. The loss of biodiversity, the transformation of the river dynamics, the destruction and fragmentation of habitats and the disappearance of the scenic landscape of Sete Quedas are hallmarks of this period.

Keywords: biodiversity, hydroelectric power plants, environmental degradation

***Resumo*:** No texto são discutidos os planos e as ações elaboradas para a salvaguarda da diversidade florística e faunística existente nas terras que foram alagadas para a forma¬ção do lago da Hidrelétrica Itaipu, entre o Brasil e o Paraguai. Para isso são analisadas as diretrizes elaboradas pela empresa responsável pela obra, que orientaram a produção dos inventários da fauna e da flora local, num contexto desenvolvimentista. A perda da biodiversidade, a transformação da dinâmica do rio, a destruição e a fragmentação de habitats e o desaparecimento da paisagem cênica das Sete Quedas são marcas deixadas pelo empreendimento.

***Palavras-chave*:** Biodiversidade; Hidrelétricas; Degradação ambiental.

***Resumen*:** El texto analiza los planes y las acciones destinadas a salvaguardar la diversidad de flora y fauna existentes en las tierras que fueron inundadas para formar el lago de la represa de Itaipú, entre Brasil y Paraguay. Para ello se analizan las directrices elaboradas por la empresa responsable de la obra, que ha guiado la elaboración de inventarios de fauna y flora, en un contexto de desarrollo. La pérdida de la biodiversidad, la transformación de la dinámica del río, la destrucción y fragmentación de los hábitats y la desaparición del paisaje escénico de las Sete Quedas son las marcas de ese momento.

***Palabras-clave*:** Biodiversidad; Energía hidroeléctrica; Degradación medioambiental."