15

LIFE
ON LAND

ITAIPU BINACIONAL

UNDESA – Itaipu Binacional SUSTAINABLE WATER & ENERGY PARTNERSHIP

PROTECT, RESTORE AND PROMOTE SUSTAINABLE USE OF TERRESTRIAL ECOSYSTEMS, SUSTAINABLY MANAGE FORESTS, COMBAT DESERTIFICATION, HALT AND REVERSE LAND DEGRADATION AND HALT BIODIVERSITY LOSS

CASE STUDY: ITAIPU AND SDG 15

Activities by ITAIPU Binacional supporting implementation of the Sustainable Development Goal 15 (SDG 15) of the United Nations 2030 Agenda for Sustainable Development

Alexandre Marchetti

15

LIFE ON LAND

PROTECT, RESTORE AND PROMOTE SUSTAINABLE USE OF TERRESTRIAL ECOSYSTEMS, SUSTAINABLY MANAGE FORESTS, COMBAT DESERTIFICATION, HALT AND REVERSE LAND DEGRADATION AND HALT BIODIVERSITY LOSS

ITAIPU BINACIONAL

UNDESA - Itaipu Binacional SUSTAINABLE WATER & ENERGY PARTNERSHIP

CATALOGING IN PUBLICATION (CIP)

Itaipu Binacional

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss / Itaipu Binacional. Dirección de Coordinación Ejecutiva. Directoria de Coordenação. Central Hidroeléctrica de Itaipu: Itaipu Binacional, 2019.
63 p.: il.; 21x29,7 cm.

Includes photographs of Itaipu Binacional.

1. Environmental protection 3. Itaipu Binacional I. Title.

CDU 364.68

Cataloging in Publication made in Biblioteca CHI-MD, Superintendencia de Ingeniería, Dirección Técnica.

General Coordination: Dirección General Paraguaya, Diretoria Geral Brasileira – Itaipu Binacional.
Editing and writing: Ariel Scheffer da Silva, Ivan Vera, Lígia Leite Soares, Maria Eugenia Alderete, Paulo Abrantes.
Text reviewer: Roberto Kozdra
Collaborators: Carmen Coronel Escurra, Emerson Suemitsu, , Gilberto Kurasz, Hudson Lissoni Leonardo, Haroldo Silva, Hilario Hermosa, Jonathan Florentin, Maria Elva Lopez, Mauricio Spagnolo Adames, Michelle Perez, Osvaldo Saucedo, Santiago Molina, Sergio Angheben, Simone Benassi, Veridiana Costa Pereira, Zalmir Silvino Cubas
Design and layout: División de Imagen Institucional - Asesoría de Comunicación Social
Print: 50 copies
Printed in 2019

Itaipu Binacional
Avda. España N° 850 e/ Perú y Padre Pucheu
Asunción, Paraguay
Tel.: (+595) 248-1909 / 248-1908
www.itaipu.gov.py

Av. Tancredo Neves, 6.731
Foz do Iguaçu, Paraná, Brasil
Tel: (+55) 45 3520-5252
www.itaipu.gov.br

CONTENTS

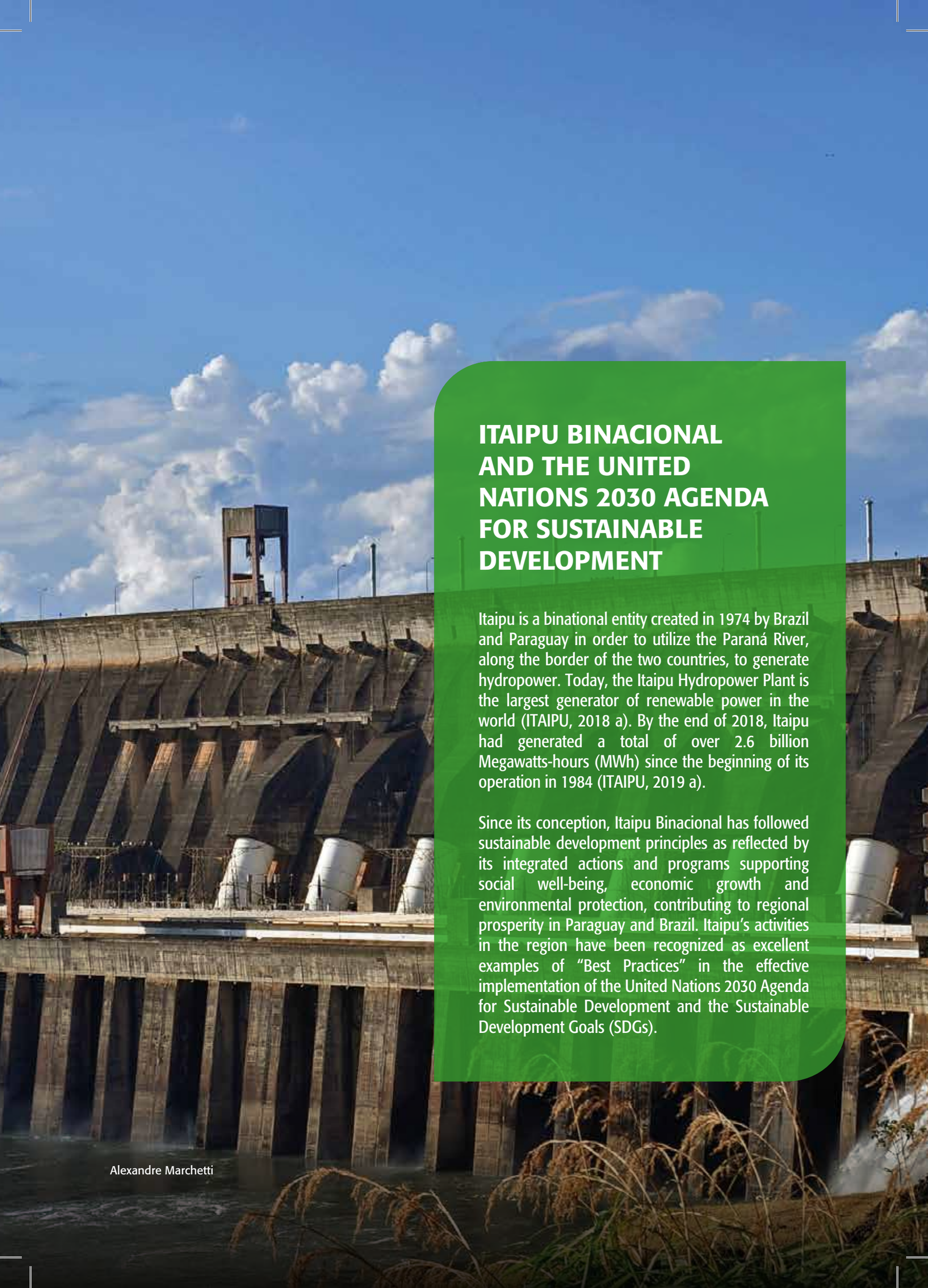
Sustainable Development Strategy of ITAIPU	9
Management, Maintenance and Restoration of Forests in the Protected Belt of the Reservoir	12
Genetic conservation for Ecological Restoration	20
Maintenance and Conservation of medicinal, aromatic, condiment and non-conventional food plants	25
Conservation of Regional Wildlife Biodiversity	28
Monitoring of Ichthyofauna (fish) in the Reservoir and in the Area of Influence of Itaipu	34
Monitoring of Invasive Exotic Aquatic Species in the Itaipu Reservoir	40
Sustainable Agriculture	45
Interlinkages with other SDGs	50
Conclusions	52
References and Additional Reading Sources	56

WHERE WE ARE

ITAIPU BINACIONAL

Paraguay Brazil

Integration that generates Renewable Energy and promotes Sustainable Development



Alexandre Marchetti

ITAIPU BINACIONAL AND THE UNITED NATIONS 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Itaipu is a binational entity created in 1974 by Brazil and Paraguay in order to utilize the Paraná River, along the border of the two countries, to generate hydropower. Today, the Itaipu Hydropower Plant is the largest generator of renewable power in the world (ITAIPU, 2018 a). By the end of 2018, Itaipu had generated a total of over 2.6 billion Megawatts-hours (MWh) since the beginning of its operation in 1984 (ITAIPU, 2019 a).

Since its conception, Itaipu Binacional has followed sustainable development principles as reflected by its integrated actions and programs supporting social well-being, economic growth and environmental protection, contributing to regional prosperity in Paraguay and Brazil. Itaipu's activities in the region have been recognized as excellent examples of "Best Practices" in the effective implementation of the United Nations 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs).

SDG 15. PROTECT, RESTORE AND PROMOTE SUSTAINABLE USE OF TERRESTRIAL ECOSYSTEMS, SUSTAINABLY MANAGE FORESTS, COMBAT DESERTIFICATION, AND HALT AND REVERSE LAND DEGRADATION AND HALT BIODIVERSITY LOSS

Target 15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements

Target 15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally

Target 15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

Target 15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.

Target 15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.

Target 15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed.

Target 15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products.

Target 15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species.

Target 15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.

Target 15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems.

Target 15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation.

Target 15.c Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities.

Source: United Nations, 2015.


Alexandre Marchetti

SUSTAINABLE DEVELOPMENT STRATEGY OF ITAIPU

Along with efficient and reliable power generation, Itaipu's sustainable development strategy recognizes that water security and sustainable development in the influence area require optimum environmental management, besides social, economic, cultural and technological development. These important objectives are the basis for the comprehensive approach and integrated plan of actions carried out by Itaipu (ITAIPU, 2019 a). Therefore, the Entity has partnered with municipalities, communities, private owners and other stakeholders for the effective implementation of this strategy, monitoring and analyzing climate variability and trends, establishing a climate monitoring platform and promoting renewable energy and ecosystem services on a regional scale.

These initiatives are part of the overall sustainable development strategy of Itaipu, specifically environmental management, which includes biodiversity conservation, environmental monitoring, and integrated management of water and soil. The overall strategy also includes social development, supporting initiatives related to social actions, health and sanitation. This approach is intrinsically linked to the SDGs of the United Nations 2030 Agenda for Sustainable Development, in particular to the objectives and specific targets of the SDGs on water (SDG 6) and energy (SDG 7).

Itaipu's vision for 2020 is to be "the generator of clean, renewable energy with the best operating performance and the world's best sustainability practices, promoting sustainable development and regional integration" (ITAIPU, 2018 b).

A model of territorial management is implemented by Itaipu in the basin of the Reservoir of the hydropower plant. The basin includes 54 municipalities in the state of Paraná and 1 municipality in the state of Mato Grosso do Sul, Brazil. In Paraguay, it includes 15 municipalities, with an overall population of almost 1.7 million people in both countries. Besides covering this territory, some actions are being carried out in other areas in Paraguay (PNUD, 2018; DGEEC, 2018).

Alexandre Marchetti

ITAIPU AND THE SDG 15

Itaipu recognizes that the effective integrated management, protection and conservation of all terrestrial and inland freshwater ecosystems located in the area are key activities supporting sustainability and bringing prosperity for the region. These ecosystems include forests and wetlands surrounding the Itaipu Reservoir and cover an area of approximately 101,000 hectares. This area represents the protected belt for the Reservoir along both the Brazilian and Paraguayan river banks. It includes natural reserves, biological refuges, and ecological corridors that protect native flora and fauna of the region and allow advance research and conservation initiatives. These areas and the Reservoir provide valuable connections among important remnants of the Atlantic Forest located in Paraguay, Brazil and Argentina.

The most important activities in Itaipu's Sustainable Development Strategy with respect to SDG 15 (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss) are centered on the following activities: implementing an integrated management program of natural resources, protecting and restoring terrestrial and inland freshwater ecosystems with the participation of local communities and all relevant stakeholders; implementing a program of forest restoration; promoting biodiversity conservation and ecosystem services recovery; and implementing a program of data collection, statistical analysis and modelling projection of parameters relevant to ecosystems, forests, desertification, land degradation, and biodiversity.

Alexandre Marchetti

1.

MANAGEMENT, MAINTENANCE AND RESTORATION OF FORESTS IN THE PROTECTED BELT OF THE RESERVOIR

Alexandre Marchetti

Objective and description

Itaipu's protected areas were created to guarantee water security and protection of the hydroelectric plant's Reservoir, as well as to promote the recovery and conservation of the flora and fauna of the area.

These protected areas consist of 101,000 hectares of land in both Brazil and Paraguay in the area of direct influence of the organization along the Reservoir. They include the biological refuges, the ecological or biodiversity corridors, the protected belt, and were designed to promote: the conservation of biodiversity within and beyond the area occupied by the reservoir; the genetic recovery of tree species; the continuous action of environmental education; and the establishment of forest nurseries for the implementation of the largest reforestation program in the world by a hydropower organization. All of these actions were structured aiming at provisioning, regulating and supporting cultural ecosystem services for nature and humans.

The Brazilian margin of Itaipu holds the biological sanctuaries Bela Vista (1,781 ha) and Santa Helena (1,482 ha), while the Paraguayan margin runs the natural reserves of Tati Yupi (2,000 ha), Pikyry (1,109 ha), Itabó (15,208 ha), Yvyty Rokai (2,202 ha), Limoy (14,828 ha), Pozuelo (2,764 ha), Carapa (2,575 ha), and the Binationally managed Natural Reserve Maracaju or Mbaracayu (1,356 ha). The protected areas in Paraguay are part of the National System of Protected Areas of Paraguay (SINASIP); therefore, they count with all the technical and legal requirements for their management.

Itaipu's effort supports the conservation of biodiversity and of terrestrial and aquatic ecosystems, and provides environmental services benefiting local communities and the Reservoir. These activities also have a positive impact at both regional and global levels by connecting Itaipu's natural areas to national parks and pristine ecosystems in Paraguay and Brazil.

In 1975, Itaipu Binacional developed the Basic Plan for the Conservation of the Environment, which was a road-map for planned activities and the vital projects,

including the constitution of the protected areas of the Reservoir (Muller, A.C., 1987). Although reforestation efforts had already begun in 1975 on the Brazilian margin, in 1976, Itaipu and the Federal University of Paraná (UFPR) conducted a forest inventory to identify, classify and qualify forest covered areas in both the Brazilian and Paraguayan margins (Soares, R.V, and Netto, S.P., 1978). It found that much of the Atlantic Forest on the Brazilian side had been cleared away for agriculture and livestock, starting in the 1960s (Eletrobras, 2011). On the Paraguayan margin, however, such agricultural development had not yet occurred, and much of the original forest was still preserved. In this sense, the reforestation program of forest ecosystems of Itaipu began earlier in Brazil than in Paraguay.

In 1979, Itaipu started implementing its largest reforestation program on the Brazilian margin, with the predominant use of native forest. Between 1979 and 1981, approximately 1.3 million tree seedlings were planted (Eletrobras, 2011).
Beginning in 2001, efforts were made to connect remnants of Atlantic Forest, resulting in the Santa Maria Ecological Corridor (1,400 km long), linking the National Parks of Iguaçu and Ilha Grande, with 185.263 ha and 76.033 ha, respectively.

In Paraguay, the Itaipu Preserva program began in 2014. It covers a very extensive territory throughout the natural reserves in the Paraguayan margin, stretching from Hernandarias to Saltos del Guaira, corresponding to 1,900 hectares of restored areas, and management of more than 400 hectares of areas under natural regeneration located in the buffer zone of the Itaipu Reservoir. A total area of 2,309 hectares has been covered.

The efforts on the Paraguayan margin include the programs Itaipu Preserva and Paraguay Biodiversidad. Itaipu Preserva focuses on the recovery of degraded areas with native forest species in the buffer zone. Paraguay Biodiversidad has worked with groups of rural producers, non-governmental organizations, and indigenous communities to restore and conserve parts of the Atlantic Forest of the Upper Paraná. A second stage of this program is focused on consolidating the Biodiversity Corridor of the Atlantic Forest of the Western Region of Paraguay. These efforts are supported by an agreement of technical cooperation with the Interamerican Institute of Cooperation for Agriculture (IICA) and an agreement with the World Bank for international technical assistance (ITAIPU, 2018 b).


ITAIPU Binacional


ITAIPU Binacional

Related Targets

The creation of Itaipu Binacional protected areas is mainly linked to targets 15.1 and 15.2, for the restoration of forests along the reservoir (Buffer Zone and Biological Refuges) and the halting of deforestation of an important biome of the region (the Atlantic Forest), thus contributing to the conservation of biodiversity in the region.

Itaipu's reforestation efforts are more specifically related to the following targets:

- 15.1: The action addresses the ecological restoration of degraded areas. That is, it seeks to recover the processes, functions, relationships, structures and the diversity of species in the original forest ecosystems. In order to know the ecological trajectory of these areas, a monitoring plan is being implemented, involving periodic evaluations and permanent forest species measurement plots.

- 15.2: The action promotes the afforestation and reforestation of areas surrounding the Reservoir and tributary water courses.

- 15.3: The action contributes to rehabilitation of soils degraded as a result of compaction, and to protect them from erosion.

- 15.5: The action contributes to the restoration of natural habitats through the use of native fruit species and the connectivity of large biodiversity groups such as the natural reserves and ecological corridors of Itaipu Binacional.

- 15.7 Through the Forest Rangers, which patrol and guard the protected areas and the protected belt, the action confronts anthropic pressures, especially poaching and the extraction of natural forest resources.

- 15.8: The action aids in the control of invasive alien species that prevent the re-establishment of native species. In the project area, invasive exotic species such as grasses (Brachiaria spp and Panicum maximum), trees (Leucaena leucocephala, Melia azedarach and Hovenia dulcis), and other types of plants are controlled.

Challenges

Challenges related to these activities include difficulty of access to the areas that need reforestation or restoration, invasion of exotic grasses, illegal entry of people, cattle entry, and soil compaction. The presence of invasive alien species, pest attacks, intentional forest fires, encroachment invasions, clandestine dumps, cattle ranching and extreme weather affect restoration activities and create negative impacts on the growth of trees. There is a need for constant monitoring, enforcement and conflict management, and for ensuring the active participation of local communities.

On the Brazilian side, the first challenge faced in recovering the Reservoir margin as a natural buffer zone was the demarcation of the boundaries between the Itaipu area and the neighboring properties. To this end, more than 8,000 concrete topographic landmarks have been set in place. In order to facilitate their visibility and make it difficult to change the boundaries, a so-called Forest Curtain (Zelazowski, V.N and Muller, A.C., 1988) was created in addition to the landmarks. This consisted in planting groups of five trees arranged every eight meters along the whole Brazilian margin of the Reservoir, for a distance of 1,395 kilometers (Zanlorensi, E. and Cordoni, J.A., 2011).

Virtually all protected areas had to be restored from the standpoint of forest cover. Initially, to meet this recovery demand, three forest nurseries were designed and built in the municipalities of Foz do Iguaçu, Santa Helena, and Guaíra, in the state of Paraná, Brazil. The choice of these locations was mainly due to the privileged geographic position of these municipalities along the Reservoir - covering its southern, central and northern portion - which facilitated the transportation and movement of the seedlings, and where there were also the Biological Refuges of the organization - larger protected areas - which served as bases for the teams.


Alexandre Marchetti

On the Paraguayan side, the biggest challenge has been to find more efficient methods for the control of invasive alien species in degraded areas in ways that can be replicated by small and medium producers.

Lessons learned

It is important to highlight that the creation of Itaipu's protected areas integrates a movement for environmental sustainability, guaranteeing water security for the generation of energy with quality, and providing socio-environmental gains with the creation of the Reservoir. The restoration and formation of ecological corridors, biological refuges and genetic banks are actions that are integrated with a policy of human, economic, technological and regional tourism development. The conservation of biological diversity is treated as a matter of national security by many countries. In Brazil, Itaipu is setting a good example for society, showing those initiatives could be expanded through effective public policies.


Alexandre Marchetti

The replication of Itaipu's restoration programs is fully feasible, partially or completely, according to the particularities of each region. In this sense, Itaipu has encouraged and assisted other organizations in the development of programs with the same vision.

For successful replication of this activity, it should be recognized that the first objective in this type of work and ecosystem must be the recovery of forest cover before the establishment of a high diversity of tree species. If diversity is considered first, maintenance costs can be very high, and the project can be deemed untenable.

In addition to rapid growth, the tree species selected for restoration must have other attributes, such as large crown development, perennial growth, early fruiting and fruits that attract birds and other dispersers.

Monitoring is essential to supporting the achievement of goals and to accompanying the trajectory of the ecosystem in the restoration process towards its self-sustainability. Adaptive management is key to ecological restoration, in that learning from mistakes is vital to moving forward.

Through these experiences, Itaipu has learned about the adoption of new restoration techniques using fast-growing plants with good canopy cover (pioneer species) during the first phase, and then enrichment with species of diversity. Protecting the soil against erosion and avoiding the elimination of weeds that do not compete with the planted individuals are other good practices. Adequate selection of species allows rapid formation of the forest canopy and a more efficient control of invasive species. The monitoring of the reforestation efforts should continue even after the work has been completed, in order to verify the success of the interventions.

Results

On the Brazilian margin, 34,000 hectares of Atlantic Forest have been restored and conserved, with the production and planting of more than 23 million seedlings, which formed the Santa Maria Ecological Corridor (1,400 km long), linking the Iguaçu National

Park to Itaipu's protection belt, and then to the Ilha Grande National Park.

The clear ecological evolution of the restored areas contrasts so sharply in the predominantly agricultural landscape of western Paraná that, in 2017, the publication of the Atlas of Regeneration of the Atlantic Forest, prepared by the National Institute for Space Research (INPE) and the NGO SOS Mata Atlântica, identified that 28% of all forest regeneration in the state of Paraná in the last 30 years is due to the protected areas of Itaipu. It is worth noting that the former Ministry of the Environment (MMA) had already recognized the area as a priority for conservation, which served as a reference for the project to create the Paraná River Biodiversity Corridor (Limont, M, Muller, C., and Soares, N., 2015).

On the Paraguayan margin, 2,309 hectares of degraded areas of the buffer zone are being restored, of which 1,900 hectares correspond to reforestation and 400 to management of regeneration and enrichment. In addition, 220 plots of degraded areas have been identified and restored, ranging in size from 0.5 to 180 hectares. In the reforestation process, 95 native species have been used, with over 2.8 million trees planted, including forest and fruit trees. In 30 years, these restored areas will sequester around 570 tons CO_2 /hectare from the atmosphere (ITAIPU, 2015).


Alexandre Marchetti

Itaipu maintains qualified professionals in its technical staff who monitor protected areas. The Entity also signs agreements with municipalities and partner institutions in the state concerning the project for ecological restoration of the areas, prevention and combat of forest fires, and actions of forest management that guarantee the perpetuation of the area.

Notable results from the creation of Itaipu's protected areas also concern the regulating ecosystem services that these forests provide. In the current scenario of climate change, for example, the role of forest vegetation in fixing carbon in its biomass is one of the most debated ecosystem services, and Brazil has offered great contributions to international agreements. The GHGs fixation by the vegetation of the protection belt and wildlife refuges both in Brazil and Paraguay are estimated at 5.9 million tons per year (Mendes, A.B., 2009).

The work has been recognized in several ways:

- Recognition of Itaipu's protected areas in the Paraguayan and Brazilian territories as core areas of the Biosphere Reserve, granted by UNESCO's "Man and the Biosphere" (MaB) Program.

- Bela Vista Biological Refuge (RBV), a protected area, named as the Advanced Center of the Atlantic Forest Biosphere Reserve (RBMA) in the context of UNESCO's "Man and Biosphere" Program.


Alexandre Marchetti

- LIFE Certification (Lasting Initiative for Earth) awarded, a pioneer process which recognizes public and private organizations that develop relevant voluntary accountable actions favorable to the conservation of biodiversity.

- An award granted by the Brazil 2016 Benchmarking Program, one of the main initiatives to certify socio-environmental actions in Brazil.

- Recognition by and support from the UN Convention on Biological Diversity (CBD), aligned with the Aichi Targets and the UN Sustainable Development Goals (SDGs), which recognize private and public institutions that take actions in favor of biodiversity conservation.

- Seal of Approval as a "Company Friend of the Atlantic Forest" received.

Alexandre Marchetti

2.

GENETIC CONSERVATION FOR ECOLOGICAL RESTORATION

Alexandre Marchetti

Objective and description

The creation of forest germplasm banks was mainly motivated by the recognition of the biodiversity risk status in forest remnants of a region in the Paraná river basin, a region that covers 28 municipalities and 8,000 km2 in Brazil, and the need to provide, in the medium term, high quality genetic material for the production of millions of seedlings for the ecological restoration of the protected areas of Itaipu and the hydrographic basin in its area of influence.

On the Brazilian margin, in 1990, during the first years of the hydroelectric project, an agreement was signed with one of the units of the Brazilian Agricultural Research Corporation, Embrapa Floresta, to test silviculture models and experimentally evaluate the development of previously little-known species of the regional flora, in addition to executing a project to restore the flora and implement the Germplasm Bank of the native Atlantic Forest biome. Genetic recovery was done through the collection of seeds in matrix trees in the region, aiming to increase the genetic base of the seeds that would be used in future restoration projects, respecting the ecological limits of the original forest (Robinson, 2011).

Initially, three nurseries were designed and built in the municipalities of Foz do Iguaçu, Santa Helena, and Guaíra, Brazil, to meet the demand for the recovery of Itaipu's protected areas and biological refuges. In these nurseries, more than 20 million seedlings were produced, destined for the organization's protected areas and, currently, also distributed to other areas in the region of the Paraná Basin.

On the Paraguayan margin, in 2018, a total of more than 1.2 million seedlings were produced, of which close to 270,000 seedlings were delivered to different beneficiary organizations, and 33.6% of the delivered seedlings were allocated to the reforestation project Itaipu Preserva, implemented by the organization in its buffer zone. Donations of plants are made to different municipalities and other organizations supporting reforestation activities at the national level. Also, plants are distributed in

different expositions with the corresponding technical assistance.

The nursery has a total area of approximately 7,000 m2, which is divided into four sectors: production in tubes, production in pots, pots filling shed, and production. There also is a warehouse for storage, processing and planting of seeds. The average annual production of the forest nursery is about 1.2 million seedlings of some 90 native forest, fruit and ornamental species.

Related Targets

The action is directly linked to targets 15.1, 15.2 and 15.5, since it establishes germplasm banks in protected areas for the conservation and reproduction of native species of the Atlantic Forest, of which many are threatened with extinction, and promotes ecological restoration at the banks of the reservoir and its tributaries with seedlings formed from a broad genetic base.

In what concerns forestry experiments, the germplasm bank and the forest nurseries were installed in the Itaipu Biological Refuges and in the Environmental Center of Itaipu. The native species produced are destined to the various socio-environmental programs developed by Itaipu, mainly reforestation in its area of protection and area of influence of the dam, as well as the afforestation of streets, avenues, squares, parks and other areas of interest of the organization and partner municipalities of Itaipu.

Challenges

In order to produce quality seedlings from the 1980s to the present day, great challenges have been overcome, from the improvement of the techniques of seed collection with scientific criteria, to the knowledge of the physiological processes for the germination of the immense wealth of native species of the Atlantic Forest biome, its development in the nursery and its survival in the field, as well as the technical aspects of selecting the best planting arrangement. Since then, the forest nursery has undergone a technological revolution. After adopting the method of production of seedlings in tubes with suspended beds, which significantly improved conditions for workers, seedling production was maximized. Controlled irrigation, light and fertilization conditions also

helped to standardize the seedlings, ensuring the maintenance of species diversity to meet demands around the year.

In relation to the production of seedlings of native forest and fruit species, slow growth and the difficulty of propagating some native species were challenging; therefore, there was a need to constantly seek to optimize the production processes to obtain the expected results.

Lessons Learned

It is necessary to combine scientific research with the real needs of the large-scale restoration process, transforming knowledge into technical guidance available to be used by technical teams. Another lesson resulting from the implementation of this action was the incorporation of regional pioneer forest coverage species in the list of species produced, oriented to the projects of forest restoration.

The experience of Itaipu's Nurseries has helped master the optimization of the activities of seed collection and cultivation and maintenance of seedlings in order to achieve more resistant plants in their final implementation in the field.

Results

On the Brazilian margin, in 2003, Itaipu and Embrapa Floresta contributed to the publication of the largest collection of information on Brazilian tree species in a series of books entitled Brazilian Arboreal Species (Carvalho, P.E.R., 2003).

The germplasm bank occupies an area of approximately 9.5 hectares where genetic recombination among accessions of germplasm is facilitated, as opposed to the isolation of matrices in forest remnants. Today it is an important Seed Collection Area (ACS) of the company for the production of forest seedlings with high genetic diversity of some species under some risk, such as Pau Marfim (Baulforodendron riedelianum) and Purple Ipê (Handroanthus avellanedae) (ITAIPU, 2009).

In the context of research and development, both the laboratory and the forest nursery are used for the professional development of the technical team as well as students of biological sciences, and related areas of knowledge, to carry out fundamental research in the solution of everyday problems related to seed technology.

Currently, the forest nursery of the Bela Vista Biological Refuge (RBV) is responsible for the production of seedlings of about 104 species of the Atlantic Forest biome, and meets all the demands of the company's environmental programs for the ecological restoration of riparian forests in the River Basin Paraná, region 3. These activities are carried out in partnership with government institutions and other partners in its 29 municipalities. Between 2003 and 2018, more than 3 million tree seedlings were produced and distributed.

On the Paraguayan margin, in 2018, a total of more than 1.2 million seedlings were produced, of which close to 270,000 seedlings were delivered to different beneficiary organizations, and 33.6% of the delivered seedlings were allocated to the reforestation project Itaipu Preserva, implemented by the organization in its buffer zone. Donations of plants are made to different municipalities and other organizations supporting reforestation activities at the national level. Also, plants are distributed in different expositions with the corresponding technical assistance.

In the forest nursery, professionals give presentations to schools, universities and other groups interested in knowing the production of seedlings of native species. Work internships are provided to high school and university students in the environmental area. Also, training and technical assistance are offered for the production of seedlings and their planting, to educational institutions of different levels, municipalities and civil organizations.
The germplasm bank is monitored annually by Itaipu to keep track of the survival and development of the species. The production of the forest nursery is monitored monthly by the organization's technical team, which issues bimonthly reports to the Itaipu Binacional Board of Directors.

Alexandre Marchetti

3.

MAINTENANCE AND CONSERVATION OF MEDICINAL, AROMATIC, CONDIMENT AND NON-CONVENTIONAL FOOD PLANTS

Alexandre Marchetti

Objective and Description

Since 2003, Itaipu has supported the development and expansion of medicinal plant gardens on both the Brazilian margin and on the Paraguayan margin of the Itaipu area of influence. These medicinal plant gardens provide the population of the region with safe access and rational use of medicinal plants, promoting the sustainable use of biodiversity and the development of the local productive chain. This action also seeks to provide the population with an alternative income to improve their socio-economic conditions through the diversification of productive activities. Another objective is to promote eco-pedagogical projects in the educational spaces of the region, to encourage the production of medicinal plants as a source of income for family farming, and to recover traditional knowledge associated with medicinal plants. Itaipu Binacional carries out this action through activities developed in the institution itself, where it has a nursery of medicinal plants.

On the Paraguayan side, a seedling nursery of approximately 4,800 m2 is devoted to this activity. The area is divided into two sections. One is devoted to the production of medicinal plants in pots/tubes, and the other focuses on mother plants, which provide the leaves for an herbalist to process and produce dehydrated herbs, packaged in envelopes and used in multiple activities.

The Brazilian side has an area of 22,000 m2 and carries out permanent activities, such as maintenance and conservation of the collection of medicinal plants and the production of seedlings. Within the model of participatory management, Itaipu had led and connected a group of entities that act with medicinal plants, and enabled the development of a production chain model for the region, in line with the National Program of Medicinal Plants and Phytotherapic thematic research, education, conservation and income generation.

Related Targets

By promoting a fair and equitable sharing of the benefits arising from the use of genetic resources and promoting adequate access to these resources, this activity is related to Target 15.6. Also, there is a direct relationship between the objective of this action and Target 15.9 in terms of promoting the sustainable use of biodiversity in the development of the local productivity chain and local job creation.

Challenges

Many laws and regulations were created and implemented over time in relation to medicinal and phytotherapeutic plants in Brazil. One of the challenges encountered is related to the official record of the collection. The maintenance of the species in the collection was also threatened over the years due to the discontinuity of contracts for the provision of services in the Medicinal Plant Garden.

Another challenge is related to the difficulty in adapting the traditional practices of the producers in terms of the processing of medicinal plants (harvest, drying and packaging), so constant training is necessary in order to successfully carry out this activity.

Lessons learned

Knowing the species used for medical purposes by the population of the region, collecting and botanically identifying the species, and having a defined strategy with a wide variety of actors involved in this activity are fundamental aspects for this effort.

It is also important to provide monitoring services to the direct beneficiaries of the project (students, teachers, small producers, and the general public that visits the project) regarding the cultivation and use of medicinal plants.

Results

Around 850,000 units of seedlings were produced in both nurseries and more than 620,000 units of seedlings were delivered to beneficiaries from 2003 through March 2019. More than 500,000 seedlings have been donated for planting in productive areas, educational gardens and scientific work.

In the Brazilian seedling nursery, about 85 species are produced annually, 34.8% of which are native species. In Paraguay, 69 varieties are produced, of which 42% are native species.

Education about medicinal plants is integral to this activity. More than 16,000 people, including health professionals, technicians and farmers, have been trained in the use and planting of medicinal plants and phytotherapeutics. The Itaipu medicinal plant nurseries also serve as a school for the public, having received more than 6,000 people since 2003.

Medicinal gardens are being established in biological reserves, in order to evaluate the growth of medicinal species in different microclimates. Workshops are conducted in different institutions (such as universities, cooperatives and associations of producers of medicinal plants) to promote the rational use of medicinal plants.

Itaipu registers and monitors the species from the collection. At present, the species of the Itaipu collection in the Brazilian margin are being sent to another herbarium, which belongs to the Federal University of Latin American Integration (UNILA), where there is a registry of 143 specimens of deposited plants. The registration of production and donation of seedlings is also carried out through a data bank, making it possible to identify the number of municipalities assisted and for what purpose the seedlings are being used.

Between 2007 and 2015, more than two tons of dehydrated plants were produced to be distributed in 50 health centers, benefiting 45 municipalities in Brazil. It is important to note that since 2015, the medicinal garden on the Brazilian margin no longer delivers dehydrated plants, in compliance with new policies adopted by the Ministry of Health regarding the incentive for phytotherapy in the country, and due to new sanitary requirements demanded for the production process.

4.

CONSERVATION OF REGIONAL WILDLIFE BIODIVERSITY

Víctor Azcona

Objective and Description

In order to mitigate the impacts of flooding the reservoir area and achieve ecological functionality of restored forests in the protection belt and biological refuges, Itaipu invested in long term in situ and ex situ wildlife conservation strategies. The conservation efforts are aimed at endangered animal species and some key seed dispersers and herbivors species.

By protecting endangered species, mostly predators, and further rewilding the forests with key fauna species, Itaipu has been assuring full ecosystem functionality and protection of the Reservoir against sedimentation and marginal erosion, among other regulating ecosystem services.

The effort to preserve biodiversity of fauna native to the Itaipu area of influence began with the Mymba Kuera (a Guarani term meaning "catching animals") project in 1982, even before the Reservoir was filled in. Through this initiative many animals were captured in the area that would be flooded by the formation of the reservoir in order to be relocated and saved. As a long-term commitment for mitigating the impacts of the reservoir creation, Biologicals Reserves, a veterinarian hospital and special animal enclosures for endangered species were then created to be refuges for thousands of plants and animals affected by the flooding that formed the Itaipu reservoir.

In 1978, the Itaipu Wildlife Research Center (CIASI) was created in Paraguay as a refuge for animals, many of which were threatened with extinction. CIASI is a Wildlife Refuge, with species of mammals, birds and reptiles that mostly represent the Atlantic Forest of Alto Paraná (BAAPA) biodiversity, as well as some species from other regions of Paraguay and Brazil. One of its main objectives is the reproduction in captivity of wildlife species with conservation problems, for their release in protected areas as population reinforcement. It currently has representatives of 29 species of mammals, 26 species of birds, and 12 species of reptiles (ITAIPU, 2018 b). The CIASI complex in Hernandarias

includes a veterinary hospital to care for the animals in the collection and others brought from the surrounding region. CIASI has an agreement with the Institute of Conservation Biology of the Smithsonian Institution in Washington, DC, for training in nutrition and care of animals.

CIASI has reproductive success in species categorized as endangered and under threat of extinction by MADES (Ministry of Environment and Sustainable Development - Paraguay) such as Marsh Deer (Blastocerus dichotomus), Pygmy Brocket (Mazama Nana), tapirs (Tapirus terrestris), White-Lipped Peccary (Tayassu pecari), Bare-Faced Curassow (Crax fasciolata) and Blue-and-Yellow Macaw (Ara arauna). With regard to birds, CIASI has 25 species, of which 7 are categories under threat, comprising 28% of the collection.

In 1984, the Wild Animal Breeding Center was built as part of the Bela Vista Biological Refuge, in Foz do Iguaçu, Brazil, to house the region's species and host the conservation and research of wildlife. Representatives of different species are kept and allowed to reproduce in properly prepared environments, with a veterinary hospital where animals from the Itaipu refuge and animals brought by the public inspection agencies receive treatment and/or rehabilitation. Staff at the Center have been successful at breeding endangered species such as the jaguar (Panthera onca), the pigmy brocket (Mazama nana), the tapir (Tapirus terrestris), the southern tiger cat (Leopardus guttulus), the margay (Leopardus wiedii), and the bare-faced curassow (Crax fasciolata), as well as the success in artificial breeding of harpy eagles (Harpia).

This way, the Bela Vista Biological Refuge maintains and manages representative population of wild fauna in captivity, constituting a living genetic bank for conservation, research and environmental awareness. Staff members also develop research initiatives and biotechnology to increase ex situ reproduction and the conservation of wild species threatened with extinction or of interest for repopulating the Itaipu protected areas.

The Bela Vista Refuge is part of Itaipu's program that aims at professional development in the conservation field and academic training, and supports scientific research of Brazilian universities. It also supports Itaipu's environmental education programs and encourages exchanges with similar institutions that also work with wildlife. In addition, the technicians of the area participate in different events and meetings at municipal, state and national levels, sharing the knowledge gained throughout the development of the action. This includes technical and operational support to the public agencies which work with the inspection, defense, rescue and protection of fauna (IBAMA, ICMBio, IAP, Military Police, Highway Police).

The Atlantic Forest portion where Itaipu is located represents the last forest pristine remnants in the region and is under high pressure of poaching, mainly on herbivores, such as tapir, deer, capybara, and other herbivores considered trophy game species.

The pressure on these species disrupts the ecological equilibrium of the forest which calls for action on poaching enforcement and herbivores population enhancement.

Itaipu leads many large in situ and ex situ conservation efforts and applied research and innovation on wildlife monitoring, landscape ecology and on the improvement of technologies that enable continuous wildlife data collection and analysis which can be replicated effectively and at low cost.

Many of the conservation research activities are developed through partnership with research institutions.

Related Targets

This activity is directly related to Target 15.5 which calls to "Take urgent and significant measures to reduce natural habitat degradation, halt biodiversity loss and, by 2020, protect and prevent the extinction of threatened species." The maintenance of captive fauna enables the future use of the species and its genetic materials for the perpetuation of the species, both in a similar ex situ conservation initiatives and in reintroduction projects.

Challenges

The implementation of this action finds challenges in the balance of coexistence between the human population and the wild fauna. Another challenge is the cultural practice of using fire before seeding crop plants and the culture of hunting wild animals. The economy of the region is based mainly on agriculture, and, in some extent in landscape based tourism. Most of the problems are related to the lack of understanding of the importance of biodiversity and its relation to ecosystem services that help to maintain a sustaining economy and a healthy environment.

Reintroduction of key faunal species or "rewilding" is an important step needed for ecosystemic services of recovery and sustainability, but there are few consistent protocols for reintroduction safety and success. Ecological balance and sustainability have to be recognized as necessary not only for the protection and longevity of the Reservoir, the main natural resource that generates clean energy and wealth, but also for the economic sustainability of agricultural and touristic activities in the region.

Lessons Learned

Environmental education and education for sustainability are key processes to cope with the challenges and promote positive and permanent impacts. Actions involving fauna conservation require partnerships and dialogue with government agencies, convening entities and the community. Itaipu recognized the need to make conservation of biodiversity a permanent action, which permeates other initiatives in the area of environment. Measures are continuously taken to ensure the safety of people and wild animals that circulate in the areas of the hydroelectric power plant and other protected areas, demonstrating the concern for balance and environmental sustainability.

Itaipu became a reference organization in social and environmental actions, and for its credibility. Being at the forefront of fauna conservation initiatives, the Entity serves as a model for all municipalities, for other companies and non-governmental organizations.

Results

From the beginning of activities with wild animals in captivity until December 2018, Itaipu has developed management plans for species threatened with extinction. Significant results have been achieved, including the birth of 1,197 animals from 54 species, some of which are at risk of extinction, such as:

- 143 pigmy brocket *(Mazama nana)*
- 19 tapirs *(Tapirus terrestris)*
- 41harpies *(Harpia harpyja)*
- 3 jaguars *(Panthera onca)*
- 30 southern tiger cats *(Leopardus guttulus)*
- 33 Margays *(Leopardus wiedii)*
- 42 bare-faced curassow *(Crax fasciolata)*

Technical and operational support to public agencies has been significant. During the period from 2006 to 2018, 998 visits were made to support government agencies for the protection of fauna and to provide veterinary services and rehabilitation of injured, sick or orphaned free-living animals.

In terms of support for education, Itaipu has participated in important publications, such as the Red Book of Endangered Brazilian Fauna (Red List) in the state of Paraná, which defines species threatened with extinction in different categories. The organization also has sponsored ten academic extension courses in the area of fauna in the period between 2008 and 2017. Regarding the land fauna, Itaipu has supported the publication of 18 master's dissertations and 4 doctoral theses, in addition to the publication of 56 papers/abstracts in scientific journals and annals of congresses. Regarding the ichthyofauna, there has been 4 doctoral theses just on the Piracema Channel, and about 120 articles have been published.

In recognition of the many efforts on biodiversity conservation, Itaipu has earned first place in the Benchmarking 2016 ranking with the "Biodiversity - Our

Heritage" program.

The results of the action are presented internally through monthly and annual reports, and, also annually, to the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), and to the public through ITAIPU's Sustainability Report. The community has access to the results of the action in visits to the Zoo and participation in environmental education activities. Periodically, videos and information are produced, as well as the dissemination of actions in social media.

5.

MONITORING OF ICHTHYOFAUNA (FISH) IN THE RESERVOIR AND IN THE AREA OF INFLUENCE OF ITAIPU

Ligia Leite

Objective and Description

Activities related to the study and monitoring of fish species in the area of influence of Itaipu have been implemented since 1977 (five years before the formation of its Reservoir), to gather information on biological and ecological aspects that allowed making decisions about biodiversity management and preservation of fish stocks, in accordance with the legislation and institutional commitments. The monitoring actions of the ichthyofauna are developed in accordance to Itaipu's overall sustainable development strategy and are based on its strategic objectives of conserving the environment and biological diversity in an integrated way according to Itaipu's 2018-2022 Strategic Planning. Activities related to ichthyofauna include:

- Fish production

On the Paraguayan bank, there is the Aquaculture Station, a research unit for artificial reproduction of native fish. It has been active since 1989 and, in 2019, upon completing 30 years of operation, it has achieved an accumulated production of more than 17 million fingerlings and fry of several native species.

The fish reproduced in the Aquaculture Station are destined for transfer to the Itaipu Reservoir and to other water bodies. The objective of these transfers is the population strengthening of threatened species and of those that suffered alteration to their migratory route due to the construction of the dam.

In January 2018, the Itabó Fingerlings Station, located in the Itabó Reserve, began operation. This unit allows to substantially increase the capacity of fry (period during which the young of fish are maintained and fed until reaching the ideal size for stocking). Stocking is carried out directly from the ponds to the southern arm of the Itabó River, by means of equipment that allows the fish to be transported through a pump and, after passing through the electronic meter, inserting them directly into the water of this river. These are strategic, referential points, at the national and regional level of Paraguay, for the protection of fishery resources of inland water courses (national) and water resources shared with neighboring (international) countries.

Top level techniques and equipment are used. For example, the Fingerling Center has automated systems with a production capacity of 500,000 fry. Once reach the minimum weight, the valves of the ponds are opened and the fish automatically pass through the electronic counter before arriving in the Reservoir.

Currently, the successful reproduction of up to twelve regional native species is carried out, such as Boga (Leporinus friderici, Megaleporinus obtusidens), Pacú

(Piaractus mesopotamicus), and Ñurundia (Rhamdia quelen), and species considered in a state of vulnerability, such as Dorado (Salminus brasiliensis), Surubí pintado (Pseudoplatystoma corruscans), Surubí atigrado (Pseudoplatystoma fasciatum) and Salmón del Paraná (Brycon orbignyanus), the latter in danger of extinction, according to the Paraguayan Ministry of Environment and Sustainable Development (MADES, 2009).

- Fish monitoring in the Itaipu Binacional Reservoir

The main work of the Ichthyofauna Action is the monitoring of fish in the Itaipu Reservoir and other water bodies of interest to the entity. Studies of the fish population have been carried out since the formation of this body of water, which occurred in October 1982. Monitoring is always relevant and is becoming more important because the environment is greatly influenced by anthropic factors. Monitoring has generated a significant volume of data, mainly in terms of species diversity, which demonstrates the complexity of the system and the succession of species that occurs over time.

- Monitoring of fish stocks – Artisanal professional fishing

This activity consists of the compilation of data from artisanal fishing and biological information of the species captured. It began in 1985, and has the participation of approximately 500 artisanal fishermen whose main source of livelihood is fishing. Daily fish catch information is reported to Itaipu by fishermen, through partnerships with the representing entities. The captured species are evaluated by monthly sampling by Itaipu at different sites along the Reservoir, where the fishermen dock their boats (ITAIPU, 2016).

- Monitoring of spawning areas and initial development

This activity consists of the collection and identification of eggs and larvae in the period between October and March, when most of the reproductive activity of migratory species takes place. It is carried out in partnership with the State University of the West of Paraná (UNIOESTE/INEO/ITAIPU, 2017). This monitoring has been carried out since 2001 on fish upstream of the dam, in tributary rivers of the Reservoir and in an extensive remnant area of the Upper Paraná River (Ilha Grande National Park, Paraná State, Brazil), sites that can support the native species.

- Sampling of the Acaray River Ichthyofauna

This study was carried out from 1991 to 1992 for the control of species stocked in the river.

- Fish Collection of the Aquaculture Station

The Fish Collection of Itaipu, which is located in the Aquaculture Station, is a scientific collection of reference, which has samples dating back to 1977. The collection currently has 867 lots, in which there is a total of 3,748 fish samples belonging to 252 species, of which 112 are registered for the Itaipu Reservoir on the right bank and surrounding areas, the rest belonging to different parts of the country.

- Studies concerning the golden mussel at Itaipu Binacional

The appearance of the invasive species Limnoperna fortunei (golden mussel) in the La Plata catchment gave rise to a series of studies in the Itaipu dam from 2001 to 2008. The focus of the studies pointed to two fronts: (1) assessing the scope, location and speed of the invasion process of the species in the potentially more sensitive areas of the Generation System, and (2) investigating viable combat alternatives for decreasing invasion impacts on the hydroelectric power plant. Work was carried out to monitor larvae and adults in order to establish the dynamics of their implantation in the plant, and to verify the annual behavior of larval and adult populations.

- Piracema Channel Monitoring – Fish transit system

The Piracema Channel, within Itaipu, is a semi-natural transposition system or migration channel with an extension of 10.3 km that acts as an ecological corridor, allowing migratory fish to overcome the barrier presented by the Itaipu dam (which has an average height of 120 meters) and reach the breeding areas in the floodplain of the Upper Paraná River, guaranteeing the gene flow necessary for the conservation of these species.

Since the beginning of the operation of this system in

2002, Itaipu has made periodic inventories to identify the species of fish present and their abundance. The movement of the migratory species inside the Channel also is monitored, using electronic tags, in order to understand the dynamics in the use of the transit system (ITAIPU, 2017 b). Recently, in addition to traditional monitoring, research using molecular biology is being developed to evaluate if the migratory species that use the Channel effectively reproduce in the tributaries and stretches upstream of the reservoir. It is a work in partnership with Universidade Federal da Integração Latino Americana (Unila). Another innovation is the research based on biomolecular tools, which intends to enable the identification of species present in the Channel through genetic materials released by fish in the water, avoiding the capture of individuals. It is part of a partnership with Universidade Federal do Paraná (UFPR).

All ichthyofauna monitoring activities support species conservation measures and strategy planning to ensure the sustainable use of available resources.

Related Targets

Monitoring fish fauna contributes to the achievement of targets 15.1, 15.5 and 15.a. Knowledge of biological aspects and ecological relationships of the assemblies of aquatic organisms, together with information on the exploration and use of the species, give support to decision-making related to the management and conservation of biodiversity and the sustainable exploitation of fish stocks.

Challenges

Challenges include the extensive reservoir area with different characteristics, high diversity of fish species occupying different ecological niches, difficulties related to participation and communication with local fishermen communities in the monitoring of fish stocks, implementation of monitoring technologies of the Piracema Channel and cross-border communication in the monitoring of migratory species.

With regard to the reproduction of fish, an important issue is the climate, which has been favorable for the production of fish in recent years, as well as the incorporation of technology for better monitoring of the activities carried out. For the monitoring of fish in the Reservoir, the extension to cover has always been a challenge. The conservation of native species becomes complicated due to the fishery pressure in the areas of the Itaipu Nature Reserve. The implementation of study projects is necessary to determine the fishing stock, and the development of terms of reference is under development.

Two other challenges are related to the development of fish farming in the open and deeper areas of the Reservoir, which will request more investments for net-pens anchoring and for the expansion of environmental monitoring efforts to constantly estimate the carrying capacity of the aquatic environment.

Lessons Learned

Monitoring programs represent the best alternatives capable of generating scientific information to assess the real needs of human interventions aimed at minimizing environmental impacts in different ecosystems. In the case of monitoring fish stocks, better results can be achieved through the commitment and participation of people from local communities in the process.

Results

Due to the 40 years of actions directed to the investigation of ichthyofauna in its different aspects and ecological interactions, Itaipu has become a reference because it has the largest reservoir studied in the Neotropical region (Agostinho et al., 2007). As a good part of these actions were developed in partnership with academic institutions, vast scientific literature was produced from the results of the monitoring activities. These actions contributed to obtaining and maintaining certifications, such as the Lasting Initiative for Earth – LIFE

(2018), a biodiversity conservation focused certification, and the Benchmarking Brazil award (Benchmarking Brazil, 2016), which aim to recognize and guide the best sustainability practices of organizations.

The inventories carried out through monitoring allowed the identification of 221 fish species in the area of influence of the Itaipu Reservoir. Biological aspects and ecological interactions of this high species richness could be described based on the data obtained, generating an enormous contribution to the field of ichthyology in the Neotropical region.

The monitoring of the fish stocks from the beginning of the reservoir formation enabled: a) the understanding of the dynamics of succession of the species in predominance due to the environmental modifications resulting from the damming; (b) the determination of the minimum sizes at which major species can be captured to maintain viable stocks; and (c) the maximum sustainable yield (in tons) of the species caught. It is currently estimated that the fishery yield of the Reservoir is 1,000 tons of fish per year or approximately 11 kg of fish/fisherman/day.

The monitoring of eggs and larvae made it possible to identify the initial spawning and initial development areas of the migratory species in the reservoir and remnants of the Upper Paraná River floodplain (Ilha Grande National Park), as well as aspects and fluctuations in the reproductive processes due to environmental variations that influence the behavior of the species. The important spawning areas and initial development of fish were mapped in a Geographic Information System and included as aquatic protected areas, an innovative class in reservoir zoning and management.

As for the reproduction of fish, since the beginning of the operations of the Aquaculture Station, more than 17 million fingerlings and fry have been produced. In 2019, the annual production record was obtained, reaching more than 3.2 million specimens reproduced, of which the majority of fingerlings and fry were stocked in the Itaipu Reservoir, and over 123,000 specimens were donated to 500 small producers from all over Paraguay, dedicated to fish farming for family consumption.

Reproduction in captivity of up to 11 species of Paraná native fish has been achieved, among which are: Dorado (Salminus brasiliensis), Doradillo (Salminus hilarii), Barred Shovelnose (Pseudoplatystoma corruscans), Tiger Shovelnose (Pseudoplatystoma fasciatum), Duckbill catfish (Sorubim lima), Pacú (Piaractus mesopotamicus), Ñurundia (Rahmdia quelem), Streaked prochilod (Prochilodus lineatus), Threespot leporinus (Leporinus friderici), Boga (Megaleporinus obtusidens) and native Salmon (Brycon orbignyanus).

The production and donation of native species fish to small producers is an important contribution to the community of fishermen interested in the activity, and for food support at the family level. Fish stocking generates a contribution to the fishery stock of the Reservoir, therefore indirectly favoring local fishermen.

Financial contribution under the Itaipu/NATURA VITA Agreement has allowed a publication for the identification of fish from Paraguay.

More than 52,500 fish belonging to 28 migratory species were tagged. Highlights for the downward migration of Curimbata (Prochilodus lineatus), which moved over 1,800 km until its recapture, and for the migration of Pacu (Piaractus mesopotamicus), which transited the Piracema Channel and the fish ladder of another hydroelectric plant, traveling more than 625 km in an upstream direction. Through this action, the migration patterns of the different species were also identified (MAKRAKIS et al., 2012).

The electronic monitoring in the Piracema Channel evidenced the transit and the patterns of movement by the migratory species.

Alexandre Marchetti

6.

MONITORING OF INVASIVE EXOTIC AQUATIC SPECIES IN THE ITAIPU RESERVOIR

Objective and Description

The monitoring of exotic aquatic species began in 1985 to find out the ecological factors that favor their proliferation and their influence on the structure of aquatic communities. As part of that monitoring, it has also been possible to monitor invasive exotic species. The monitoring of aquatic species is performed in the Itaipu Reservoir, in outlets distributed in the reservoir and in the eight main arms of the Brazilian margin, in the case of fish and aquatic plants. In the case of the golden mussel, the action is carried out within the generating units of the hydroelectric power plant.

The actions developed by Itaipu in relation to invasive exotic species are carried out within the scope of the Environmental Monitoring Program, which evaluates the water and water fauna conditions of the reservoir and its tributaries. The invasive exotic species in the monitored area are the Golden Mussel (Limnoperna fortunei), some fish species and the Aquatic Macrophytes (Hydrilla verticillata and Urochloa subquadripara).

The golden mussel (Limnoperna fortunei) is a bivalve mollusk originating from rivers of Southeast Asia, which was introduced into South America in the ballast water of merchant ships. After the detection of this species in 2001 (CANZI et al., 2014), Itaipu mapped susceptible points to possible impacts to the generation of energy and initiated the monitoring of environments that were considered vulnerable.

Over the years, control measures have been tested for several species. Itaipu has also been actively participating in governmental initiatives to control species dispersal and bioinvasion (Environment Ministry, 2004). Currently, evaluations of a filtration system are being carried out (in loco) to contain the larvae of this species.

Monitoring of invasive exotic fish species occurs through the compilation of information from professional and amateur fishing activity, as well as biological information obtained from fish

disembarkation assessments. There are records in the Itaipu Reservoir of at least 11 exotic species. Among them, four species come from the Amazon and Tocantins basins and have established themselves as invaders with high abundance in the area, such as Tucunare (Cichla kelberi and Cichla piquiti), Cara (Geophagus sveni) and Corvina (Plagioscion squamosissimus), species present in the region before the formation of the Reservoir (CETESB/ITAIPU Binacional, 1979). To reduce possible impacts, Itaipu disseminates information and encourages the capture of these species through professional and amateur fishing activity.

The monitoring of aquatic plants (aquatic macrophytes) began in 1996, and aims to identify the factors that affect the communities of macrophytes, and those that propitiate the success of invasions and the effects of invasive plants on the communities. Five exotic species are recorded in the Reservoir, with only two invasives: Hydrilla verticullata (native to Asia and North Africa) and Urochloa arrecta (native to Africa). In monitoring, the biodiversity index and the relative abundance of the species are calculated. In each arm of the Reservoir, the maximum depth of occurrence of the main invasive species is also calculated as a way of predicting the occurrence limits and the places where these plants can cause problems for the multiple uses of the waters of the Reservoir.

Related Targets

By monitoring aquatic species, Itaipu directly contributes to achieving targets 15.1 and 15.8. There is no way to ensure conservation, nor to perform actions to recover aquatic ecosystems without first knowing the variability of the present species and the ecological relations of aquatic organisms. Monitoring and studying the factors that trigger the permanence of invasive exotic species and the influence of these species on other aquatic communities is only possible through long-term monitoring studies.

Itaipu has been monitoring and studying the aquatic species since before the formation of the Reservoir and currently knows the exotic species that are invasive and the factors that can favor their proliferation. Through this knowledge, the organization proposes mitigation measures to reduce the impacts that invasive species can cause to the ecosystem and to the multiple uses of the Reservoir waters. All these actions are carried out in partnership with academic insitutions and its purpose is to assist the conservation and sustainable use of biodiversity and ecosystems. Several works are published in the literature on the subject.

Challenges

Due to the extensive area of the reservoir and the rapid dispersal and proliferation characteristics of invasive species, they represent a major challenge of control and eradication. Another determining factor is the awareness of the local community and of users of the Reservoir regarding the problems that invading exotic organisms can cause in relation to the multiple uses of water and the responsibility that each person has to avoid the introduction and to hinder the dispersion of these species.

Lessons Learned

Monitoring programs represent a safe, economical and scientifically justifiable alternative to assess the real needs of human interventions in order to to minimize environmental impacts in different ecosystems (Thomaz, 2003). Whatever the action or strategy for species management, especially invasive exotic species, it should be associated with a continuous monitoring program, because there may be doubts about the success of the action's efficiency. For this reason, Itaipu maintains a continuous long-term monitoring program for aquatic species, and the results indicate the priority areas for the conservation of the Reservoir's biodiversity. In addition, for more effective results, the commitment of society is necessary; it must act in a participatory way to avoid introducing and to hinder the dispersal of invasive exotic species.

Results

Aquatic macrophytes continue to colonize relatively shallow areas of the Reservoir, and there is no evidence that massive explosions capable of affecting power generation will occur. The largest development occurs in areas far from the central body of the Reservoir. Among the 60 species of aquatic plants identified since the beginning of monitoring, invasive exotic species are among the five most abundant observed. Urochloa arrecta, the main species in abundance, causes serious damage to aquatic biodiversity and difficults the access to the Reservoir (Michelan et al. 2010). The species Hydrilla verticillata, verified as of 2010, due to the depth of colonization of the species (deeper zones than the native species), presents low potential to affect the energy production. Despite the multiple use impact of macrophyte invasion, to date, there is no evidence that the species adversely affects the Reservoir's biodiversity, and therefore more research is needed.

The community can contribute to avoiding the proliferation of invasive species by washing boats and other vessels thoroughly, including kayaks used for leisure activities, in order to eliminate the presence of invasive larvae species. At these sites, the size of colonized areas is sufficiently reduced, and manual collection of invasive species is employed with relative success.

In the case of Golden Mussel, dissemination campaigns were carried out throughout the region, explaining the occurrence and the forms of identification of the species, as well as the description of the main mitigating measures for the control that the community can carry out. The population of golden mussel stabilized and a decrease in the abundance of the individuals after the first years of infestation was verified during 17 years of monitoring. It was found that temperature had a marked influence, acting as a limiting factor to the reproduction of the species in winter periods (ITAIPU Binacional, 2013). In terms of electric power generation, there was no compromise by the presence of the species, mainly due to the dimensions of Itaipu dam systems. Adaptations in filters and pipes of the cooling systems of the machines, together with periodic mechanical cleaning, guarantees the availability of the electricity generating units, without signifcant increase in the cost of maintenance.

As for the species of invasive fish, these began to comprise the catches made by professional fishing in the Reservoir, equivalent to approximately 17% of the fish caught (ITAIPU, 2016). In addition to the importance of commercial fishing, these species are the basis of amateur fishing undertaken for recreation purposes and responsible for promoting regional fishing tourism (INEO/ITAIPU, 2016).

Itaipu conducts monitoring of aquatic macrophytes in partnership with the State University of Maringá (UEM) under the coordination of worldwide recognized specialists in the subject. Itaipu monitors all activities and receives reports on the occurrences. The data is made available to the community through the company's Sustainability Reports. In certain areas of the Reservoir, where there are recreational practices (artificial beaches), municipalities and/or clubs receive guidance on how to carry out the control and management of invasive aquatic plants.

Victor Azcona

7.

SUSTAINABLE AGRICULTURE

Alexandre Marchetti

Objective and Description

Since 2002, Itaipu Binacional has been promoting sustainable rural development and the reduction in the use of contaminants in agricultural activities in the water contributing areas of the reservoir and in other areas of interest to Itaipu. This program promotes the diffusion of the agroecological production system for the conversion of conventional production systems to organic production systems through a Technical Assistance and Rural Extension network (ATER). Access to the network, which is based on the dissemination of sustainable production practices focused on local productive arrangements, is free for all family farmers in the region.

The action is made possible through formal contracts and agreements between the sponsoring organizations (Itaipu and Municipal Prefectures) and the executing and partner organizations (Center for the Support and Promotion of Agroecology - CAPA and Cooperative of Labor and Technical Assistance of Paraná - Biolabore) that serve all partner associations and cooperatives of the project partners. The program works on several fronts, such as:

- Support to the research, development and teaching of family farming and organic agriculture; training of teachers, researchers and students through agreements with the State University of West Paraná (Unioeste).

- Support to technological innovation, with the use of homeopathy in agriculture, developing a system of direct organic farming (SDOF), and investing in courses, seminars and publications on the subject.

- Assistance in the process of certification and commercialization of organic products.

- Publicizing the benefits of organic production to the population, seeking the creation of social, environmental and commercial direct links, from rural

to urban environments. The information is desiminated through lectures in schools and by the promotion and participation in events, with booths, promotional materials and sale of organic products from family-based farming.

The promotion of sustainable agriculture considers technical and economic aspects for the development and perpetuation of family-based farming. Therefore, the program encourages the diversification of production and the improvement of property management. This work is carried out periodically by ATER, on the occasion of the technical advisories to the rural properties in interval of 15 to 90 days, according to the type of productive activity.

Related Targets

This activity is directly related to targets 15.2, 15.3 and 15.5 as follows:

15.2: The norms for organic certification envisage the environmental improvement of properties to meet the Brazilian forest code that foresees the forest restoration of riparian forests and other areas of preservation and legal reserve. Therefore, with the increase in the number of organic farms, there will be a consequent positive impact related to this target.

15.3: The Sustainable Rural Development Program (DRS) advises farmers to use the soil in a sustainable manner, using soil conservation techniques, respecting the limits of usage capacity, reducing degradation.

15.5: In areas where the most sustainable organic production is developed, there is an increase in biodiversity due to reduced use of chemical inputs. It is now agreed that agroecology introduces ecological benefits due to the attenuation of water and soil pollution, as well as the conservation of biodiversity (Nodari, 2015).

Challenges

The challenges faced include the following: increase in the production and consumption of organic food; expanding and maintaining the network for technical assistance; developing current production chains; strengthening associations and cooperatives; supporting the research, development and teaching of agroecology; and measuring socioeconomic results through indicators.

Lessons learned

One of the main lessons learned in structuring a complex program with a regional dimension is that there should be a continuous planning of activities and actions, with periodic review and constant monitoring, ensuring the participation of all relevant stakeholders involved.

A contribution that deserves to be highlighted with regards to the success of the practice was the participatory methodology used to develop ATER, agroindustrialization and marketing actions and stimulating integration among them. In this process, it was essential to have an active Management Committee with broad participation of those involved in the project. The institutional support of Itaipu through the DRS program was crucial to making the project viable during its 17 years of existence, by providing methodological, technical and financial support.

Results

There has been a significant evolution in the quality, quantity and variety of products and organizations devoted to organic farming. In addition to the insertion of organic products into the institutional market, farmers have sought the investment and expansion of their agroindustries and points of sale so that their products can be commercialized in small quantities, with more direct relations between the producer and the final consumer.

Alexandre Marchetti

There was significant increase in beneficiaries of the program, which started with 188 families and now serves approximately 2,500 family farmers, including those from indigenous communities.

In 2018, there were 3,539 in situ counseling sessions on rural properties and 169 group training activities involving 2,666 farmers.

Seven cooperatives and 135 family agriculture agroindustries were advised on labeling, branding, nutritional information and product standardization, aiming to expand the commercialization with greater added value to the products, providing income improvement and strengthening economic development in the region.

Itaipu monitors the results by keeping track of the monthly reports sent by the managers of the current contracts and of agreements, comparing them with the pre-established goals, seeking to execute the goals and correcting possible obstacles to the success of the work. In addition, Itaipu's managers monitor the execution of practices in the field, verifying the quality of production. The project also has an active Management Committee which meets every 60 days. It is composed of representative organizations from the civil society, farmers and governments sectors, and allows the active participation of their peers. In the meetings, the guidelines, actions and evaluations of the program are built, guaranteeing legitimacy to the results achieved.

Alexandre Marchetti

INTERLINKAGES WITH OTHER SDGs


Alexandre Marchetti

Activities related to terrestrial ecosystems, forests and biodiversity (SDG15) can be interlinked with most of the other SDGs. The strongest interlinkage is related to climate change (SDG13), as the restoration of forests enhances the absorption of CO2. The interlinkage is also very strong in relation to water (SDG6), energy (SDG7), and economic growth (SDG8). Another strong interlinkage is with respect to partnerships (SDG17), given Itaipu's partnerships with international, national, local and regional organizations committed to the protection of water and terrestrial ecosystems and to the pursuit of sustainable development. These activities also are interlinked with SDG2 because of sustainable agriculture and nutrition, SDG 3 because of medicinal plants, SDG 4 because of education, and SDG 12 because of sustainable production of agricultural products.

CONCLUSIONS


Alexandre Marchetti

The sustainable development strategy of Itaipu and its comprehensive program of activities related to reforestation and the conservation of terrestrial and freshwater inland ecosystems represent an excellent example of the implementation in the field of the SDG15 and the UN 2030 Agenda for Sustainable Development.

The strong interconnection among reforestation, water and climate change are evident for Itaipu, and the current activities and policies related to reforestation are key to support global efforts on the conservation of biodiversity of flora and fauna.

Aware of the negative impacts that creating a reservoir would have on local flora and fauna, Itaipu has been implementing a comprehensive and extensive program of reforestation and remediation in its areas of influence for decades. Itaipu has also been restoring habitats that create an opportunity for endangered flora and fauna to reproduce and overcome the threat of possible extinction. Its support of appropriate farming methods has resulted in soil conservation and the reduction of erosion, which aid in the restoration of degraded lands. Finally, Itaipu has been implementing a comprehensive program on data collection, statistical analysis and parameter simulations that allow the assessment of the status of different species of flora and fauna in the areas of influence. The monitoring programs and research activities of aquatic species are extensive and comprehensive in the Reservoir and in the area of influence of Itaipu.

A summary of specific accomplishments resulting from Itaipu's reforestation and biodiversity activities is illustrated in the diagram below. The diagram demonstrates the integrated and interconnected approach of Itaipu with respect to the social, economic and environmental dimensions of sustainable development.

SDG15 LIFE ON LAND

Almost **500** watersheds being managed with Direct Planting System

Approximately **25 million** seedlings planted for reforestation in both countries

2,500 family farmers were provided technical assistance for conversion from traditional farming to sustainable and organic agriculture

Breeding in captivity of **54** species of wildlife, some threatened with extinction

SOIL CONSERVATION

BIODIVERSITY

Almost **40,000 HA** managed for soil conservation

Monitoring of 28 species of migratory fish

Thousands of rural producers provided technical assistance in soil conservation techniques

In 30 years, more than **17 million** fingerlings and fry were produced and transferred into the Reservoir.

ECOSYSTEM SERVICES

Itaipu restored and protects more than **100,000** hectares of the Atlantic Forest, which fixes 5.9 million tons of CO_2 equivalent per year

Itaipu's protected areas recognized as core areas of the Biosphere Reserve by UNESCO's Man and the Biosphere Program

REFERENCES AND ADDITIONAL READING SOURCES

- Agostinho, A.A, Gomes, L.C, Mayer, FM. (2007). Ecologia e manejo de recursos pesqueiros em reservatórios do Brasil. Maringá, Brazil: Eduem.

ITAIPU Binacional. (2016). Itaipu emplaca dois primeiros lugares no benchmarking. Retrieve from: https://www.itaipu.gov.br/sala-de-imprensa/noticia/itaipu-emplaca-dois-primeiros-lugares-no-benchmarking-2016

Bini, L. M. (1999). Aquatic macrophyte distribution in relation to water and sediment conditions in the Itaipu reservoir, Brazil. Hydrobiologia. 415. 147-154.

Itaipu Binacional. (2012) Projeto Plantas medicionais: Cartilha informativa. Retrieved from: http://www.boaspraticas.org.br/attachments/article/196/Cartilha%20Projeto%20Plantas%20Medicinais.pdf

Brancalion, P. H., Gandolfi, S., & Rodrigues, R. R. (2015). Restauração florestal. Oficina de textos. 432 p.

Canzi, C. et al. (2014). Monitoramento e ocorrência do mexilhão dourado (Limnoperna fortunei) na hidrelétrica da Itaipu binacional, Paraná (BR). Revista Ibero-Americana de Ciências Ambientais, , 5 (2), 117-122.

Carvalho, P.E. (2003). Espécies Arbóreas Brasileiras, Embrapa Informação Tecnológica. Colombo, Brasil, 1-5, 1039

Casão, R. et. al. (2006) Sistema Plantio Direto com Qualidade. Londrina-Pr
Certificação LIFE – Resumo Público da metodologia LIFE, validated in 08/11/2018.

Case Studies. (2019). Itaipu Binacional: o projeto de plantas medicinais da usina com fins de saúde, sustentabilidade e desenvolvimento. Retrieved from: http://casestudies.com.br/itaipu-binacional-o-projeto-de-plantas-medicinais-da-usina-com-fins-de-saude-sustentabilidade-e-desenvolvimento/

Coletto, L.M., Ruppelt, B. M., Cardozo, E. L. (2010). Plantas medicinais nativas dos remanescentes florestais do oeste do Paraná

Companhia de Tecnologia de Saneamento Ambiental/Itaipu Binacional. (1979). Itaipu Binacional-Ictiofauna. Curitiba, Brasil: CETESB

Companhia de Tecnologia de Saneamento Ambiental/Itaipu Binacional (1981). Itaipu Binacional-Ictiofauna: Complementação do Inventário Ictiofaunístico. Vol 3. Curitiba, Brasil: CETESB

Cubas, Z.S., Moraes, W., de Oliveira, M.J., de Perez, M.P.C., Suemitsu, E.S., Almeida, R.P. (2017). Conservação e manejo da fauna terrestre na Itaipu Binacional. In Adriana Coli e Pedro Dias (Coord.), O Setor Elétrico e o Meio Ambiente. Rio de Janeiro, Brazil: / Synergia: FMASE.

Debiasi, H. et al. (2018). Desempenho Técnico e Econômico de Modelos de Produção Diversificados na Região Centro Norte do Estado do Paraná. Annals of the Workshop of Rede de Pesquisa Solo Vivo.

De Resende, A. S. & Leles, P.D. (2017). Controle de plantas daninhas em restauração florestal. Embrapa Agrobiologia-Livro técnico (INFOTECA-E). 107 p.

Eletrobras. (2011). Gestão do uso e ocupação das bordas dos reservatórios das usinas hidrelétricas das empresas da Eletrobras:Diagnóstico e proposição de diretrizes. Versão preliminar 4. Volume ii – anexos.

Embrapa. Diversification of plant species as a basis for the sustainability of soybean crop. Documentos Embrapa number 366. Available at: https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1036787/1/doc366OL.pdf

Decree 7620-7472-7471-7445-7444-7449/2017. Por el cual se declara como Área Silvestre Protegida Bajo Dominio Privado las Reserva Natural Limoy, Pikyry, Pozuelo, Yvyty Rokái, Itabo, Carapa. IDEA. Available at: http://idea.org.py/decretos-reglamentarios/

DebiasI, H., Franchini, J. C, Balbinot Junior, A. A., Betioli Junior, E., Nunes, E. da S., Furlanetto, R. H., Mendes, M. R. P. (2017) Alternativas para diversificação de sistemas de produção envolvendo a soja no norte do Paraná. Embrapa Soja (398). Retrieved from:

https://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/1086382

Embrapa (2019). Avaliação Ex-Ante do Índice de Qualidade Participativo do Plantio Direto com Produtores do Centro Sul do Brasil. Embrapa Soja (203). Retrieved from: https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1104307/1/CNPSDOC2032018.pdf

Fontes Junior, H.M.; Moraes, W. & Carbonar, F.J.S. (1992). Criação em cativeiro de Galictis cuja (Molina) (CARNIVORA, MUSTELIDAE). Furão. Paper presented at XVI Congress of the Zoological Society of Brazil, Americana, SP.

Franchini, J. C. et al. (2018). Índice de Qualidade Participativo do Plantio Direto e sua relação com a produtividade e o desempenho econômico de modelos e produção. Paper presented at Workshop of Rede de Pesquisa Solo Vivo.

Gimenes, W.M. (2011). Estabelecimento de métodos para germinação de sementes de Chrysophyllum gonocarpum (Mart.&Eichl Engl.). Trabalho de Conclusão de Curso. Anglo Americano.

Gill Morlis, W. (1996). Peces del embalse de Itaipu. BIOTA. Ciudad del Este, Paraguay: EMASA

Gill Morlis, W. (2006). Control de siembra en el embalse Acaray. Ictiofauna del Río Carapá. BIOTA. Ciudad del Este, Paraguay: EMASA.

Gill Morlis, W. (2006). Ictiofauna del río Acaray. BIOTA. Ciudad del Este, Paraguay: EMASA

Hermosa, J.L. y Martínez, A. (2011). Estudios sobre el mejillón dorado en la ITAIPU Binacional. BIOTA. Ciudad del Este, Paraguay.

INEO/ITAIPU (2016). (Instituto Neotropical de Pesquisas Ambientais – Universidade Estadual do Oeste do Paraná/Itaipu Binacional). Relatório de Avaliação da Pesca Esportiva no Reservatório de Itaipu

Instituto Ambiental Do Paraná – IAP (2009). Monitoramento da qualidade das águas dos reservatórios do Estado do Paraná no período de 2005 a 2008: relatório técnico. Curitiba: IAP, 120 p.

The International Center on Renewable Energy (CIBiogás). Available at: https://www.cibiogas.org/en

ITAIPU Binacional Energy
https://www.itaipu.gov.br/en/cover-energy

ITAIPU Binacional Environment
https://www.itaipu.gov.br/en/cover-environment

ITAIPU Binacional Sustainability Reports
https://www.itaipu.gov.br/en/social-responsibility/sustainability-reports

ITAIPU Binacional Meio Ambiente
https://www.itaipu.gov.br/meioambiente/sig-livre

ITAIPU Binacional. (1982). Plan director del embalse de Itaipu. 66 p.

ITAIPU Binacional. (2000 b). Plan director de gestión ambiental. 30 p.

ITAIPU Binacional (2009). Relatório de Sustentabilidade.

ITAIPU Binacional (2013). Relatório de Sustentabilidade.

ITAIPU Binacional (2015). Comunicación de progresso y reporte de sustentabilidad. Itaipu Lado Paraguayo. Available at: https://www.itaipu.gov.py/es/responsabilidad-social/comunicacion-de-progreso-y-reporte-de-sustentabilidad

ITAIPU Binacional (2016). Relatório de Sustentabilidade.

ITAIPU Binacional (2017). Relatório de Sustentabilidade.

ITAIPU Binacional (2016). Relatório anual da Divisão de Reservatório – MARR.CD.

ITAIPU Binacional, Strategic Planning : https://www.itaipu.gov.br/institucional/planejamento-estrategico

ITAIPU/UNILA (2017). Acordo de cooperação JD.JE/0018/17 – Technical-scientific cooperation agreement to "Atividades de pesquisa relacionadas ao Canal da Piracema enquanto ferramenta de conservação da biodiversidade".

ITAIPU Binacional. (2018 a). Sustainability Report 2017. Foz do Iguaçu, Paraná: Social Responsability Advisory Office.

ITAIPU Binacional. (2018 b). Comunicación de progreso y reporte de sostenibilidad 2017: ITAIPU lado Paraguayo. Retrieved from https://www.itaipu.gov.br/es/responsabilidad-social/comunicacion-de-progreso-y-reporte-de-sustentabilidad

ITAIPU Binacional. (2018 c). Itaipu Binacional. The largest generator of clean and renewable energy on the planet. Itaipu Binacional Social Communication Office

ITAIPU Binacional. (2019 a). Generación. Retrieved from http://www.itaipu.gov.py/es/energia/generacion

Instituto Life – Lasting Initiative For Earth https://institutolife.org/sobre-o-instituto/

Limont, M., Müller, C., Soares, N. (2015). Ações de governança territorial da Rede Gestora do Corredor de Biodiversidade do Rio Paraná. Porto Alegre: Instituto Curicaca, 84 p.: il.color.

López Vera, ME., Gill Morlis, W., Saucedo, O. y Bernal, J. (2018). Evaluación de la protección de la fauna ictica en siete reservas naturales de la Itaipú Binacional margen paraguaya. Anais e Resumos do XXXII Congresso Brasileiro de Zoologia, Foz do Iguazu, Brasil. DOI: 10.5281/zenodo.1341248. https://zenodo.org/record/1341248#.XbtXBuhKjIU

Makrakis, S. et al. (2012). Diversity in migratory patterns among Neotropical fishes in a highly regulated river basin. Journal of Fish Biology, 81: 866–881.

Mendes, A.B. (2009). Quantificação do Montante de CO2 armazenado na vegetação que compõe a Faixa de Proteção do Reservatório da Usina Hidrelétrica de Itaipu – Margem Brasileira. Dissertação de curso de especialização. Universidade Positivo, PR, 88 p.

Michelan, T. S. et al. (2010). Effects of an exotic-invasive macrophyte (tropical signalgrass) on native plant community composition, species richness and functional diversity. Freshwater Biology (Print), v. 55, p. 1315-1326.

Ministério do Meio Ambiente (2004). Relatório da Força Tarefa Nacional para controle do mexilhão dourado.

Moraes W.; Fontes Junior, H.M.; and Carbonar, F.J.S. (1992). Conservação e manejo de Mazama rufina (ARTIODACTYLA, CERVIDAE) em cativeiro. XVI Congress of the Zoological Society of Brazil, Americana, SP.

Muller, A.C. (1987). Plano Diretor da Área de Reservatório. 2º Seminário da ITAIPU Binacional sobre Meio Ambiente. Foz do Iguaçu, Paraná, 12 a 16 de outubro, p. 19-26.

Neris, N., Villalba, F., Kamada, D. y Viré, S. (2010). Guía de peces del Paraguay. Asunción, Paraguay. Artes Gráficas Zamphirolos S.A. ISBN: 978-99953-854-3-9

Nitsche, P. R. (2019). Aplicativo para smartphones e tablets, denominado IAPAR Clima, para a obtenção de informações meteorológicas em tempo real. Available at: https://play.google.com/store/apps/details?id=iapar.br.iaparclima

Nodaril, R. O. and Guerra, M. P. (2015). A agroecologia: estratégias de pesquisa e valores. Estud. av., São Paulo , v. 29, n. 83, p. 183-20. Available at: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-40142015000100183 >.

Oliveira, L. H. P. De (2019). Influência de rotações de culturas sobre atributos físicos do solo. Dissertation. IAPAR. Londrina-pr.

ITAIPU e PTI desenvolvem sistema de monitoramento climatico https://www.oparana.com.br/noticia/itaipu-e-pti-desenvolvem-sistema-de-monitoramento-climatico

Pin, Ana et al. (2009). Plantas Medicinales del Jardín Botánico de Asunción. 1 ed. Asunción: Asociación Etnobotánica Paraguaya.

Plan Director de Gestión Sociambiental de la Itaipu Binacional https://www.itaipu.gov.py/es/medio-ambiente/politica-ambiental

Ralisch, R. et al. (2017). Diagnóstico Rápido da Estrutura do Solo – DRES. Available at: https://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/1071114

Ramos, G. (2003). Contribución al conocimiento de la reproducción de peces nativos en cautiverio. BIOTA. Ciudad del Este, Paraguay.

Robinson, I.P. (2011). Banco de Germoplasma de Espécies Nativas. Relatório Técnico.

Roloff, G., et al. (2011). Validação do Índice de Qualidade Participativo do Plantio Direto. Boletim Técnico da Federação Brasileira de Plantio Direto na Palha. Available at: https://www.febrapdp.org.br/peqp3/publicacoes/Validacao_Indicie_de_Qualidade_do_Plantio_Direto,_2011.pdf

Rollof, G. et al. (2013). Índice de Qualidade Participativo do Plantio Direto. Available at: https://www.sbcs.org.br/cbcs2013/anais/arquivos/1874.pdf

Rosa, J.M. and Nolasco, G. (2018). Projeto Harpia 20 anos. Itaipu Binacional.

Santos, L.C. Laboratório Ambiental (1999). 1st.ed. Cascavel: Edunioeste, 341p.

Santos, L.C. Laboratório Ambiental (2011) 2nd ed. Cascavel: Edunioeste, 404p.

Sharapin, N., Pinzon, R. et al. (2000). Fundamentos de tecnologías de productos farmacéuticos. Colombia.

Soares, R. V. Netto, S. P. (1978). Inventário da Região de Influencia da Represa de ITAIPU. Centro de Pesquisas Florestais do Setor de Ciências Agrarias – Universidade Federal do Paraná, Curitiba, PR.

Sória, M. A. (2012). Usina de Itaipu – Integração energética entre Brasil e Paraguai. 1. ed. Curitiba: UFPR, 251p.

SRI Monitoramento Climatico desenvolvido no PTI integra dados de mais de 100 estacoes do PR http://sri.oesteemdesenvolvimento.com.br/noticias/monitoramento-climatico-desenvolvido-no-pti-integra-dados-de-mais-de-100-estacoes-do-pr/

Horta de plantas medicinais em Santa Terezinha de Itaipu http://www.stitaipu.pr.gov.br/noticias/item/2221-horta-de-plantas-medicinais-em-santa-terezinha-de-itaipu.html

Thomaz, S. M. (2002). Fatores ecológicos associados à colonização e desenvolvimento de macrófitas aquáticas e desafios de manejo. Planta Daninha, Viçosa, v. 20, p. 13-25.

Thomaz, S. M. et al. (2006). Effects of reservoir drawdown on biomass of three species of aquatic macrophytes in a large sub-tropical reservoir (Itaipu, Brazil). Hydrobiologia, v. 570, p. 53-59.

Tiepolo, G. M. et al. (2017). Atlas de Energia Solar do Estado do Paraná. 1a Edição. Curitiba: UTFPR.

UNIOESTE/INEO/ITAIPU (2017). Relatório anual – Estudos de Ovos e Larvas de Peixes no Reservatório de Itaipu e Trecho a Montante.

United Nations: Transforming Our World (SDGs and the 2030 Agenda for Sustainable Development). Available at: https://sustainabledevelopment.un.org/post2015/transformingourworld

Villalba, F. y Gill Morlis, W. (2018). Colección de peces de la estación de acuicultura de la ITAIPU Binacional. BIOTA. Hernandarias, Paraguay.

Villalba, F., Viré, S. y Resquín, J. (2012). Peces el Paraguay: Guía e Identificación de setenta especies. Asunción, Paraguay. ARG Servicios Gráficos. ISBN 978-99967-625-2-9

Villar del Fresno, A. (2010). Farmacognosia general. Editorial Síntesis- Madrid. España.

Western Paraná Energy Planning available at: https://observatoriopti.wixsite.com/planoenergetico

Zanlorensi, E. Cordoni, J. A. (2011). Diagnóstico e proposições de diretrizes para Bordas de Reservatório. Vol.II. Itaipu.

Zelazowski, V. H. and Muller, A. C. (1988). A Cortina Florestal como Visualização da Linha Divisória da Área do Reservatório de ITAIPU – ME. In: Congresso Florestal Do Paraná, Curitiba. Anais. Curitiba:UFPR, p. 360 – 407.

Victor Azcona


ITAIPU
BINACIONAL

ITAIPU BINACIONAL

UNDESA – Itaipu Binacional
SUSTAINABLE WATER & ENERGY PARTNERSHIP

15

LIFE ON LAND