Project Brief

Small Grants Program:

The role of ecosystem services in adaptation to global change for human wellbeing (SGP-HW)

[SGP-HW 091] Improving the governance of the floodplain in over-built river basins

Floodplain of the Parana River Basin: Livelihood and Biodiversity Restoration

SDGs: Goal 15 (Life on land)

In response to the growing demand for water, humankind has increased investment in water infrastructures over the last century, bringing about excessive water usage and over-built river basins in the end. Basins now use water more than it is environmentally desirable, and water reallocation is needed to sustain ecosystems. Yet, altering the flow regime of large rivers involves multidimensional –technical, economic, and sociopolitical– interventions, including the degradation of aquatic and riverine ecosystems. Local populations, therefore, have become much more vulnerable to shocks such as hydro-climatic events, energy prices, and crop prices.

The project Improving the governance of the floodplain in over-built river basins has researched the reach of the Paraná river downstream of Porto Primavera dam in Brazil, with funding from the Inter-American Institute for Global Change Research (IAI). By quantifying and interpreting flow dynamics via computer modeling, scientists have been working to understand ecological effects on large wetlands and floodplains downstream of hydropower plants and achieve policy integration across the fields of energy and environment for effective ecosystem governance.

The research team has also established the linkages between users and ecosystem services. Findings show that several important socio-economic activities depend directly or indirectly on fish and their ecosystems, such as recreation, tourism, and professional fishing. It is worth noting that these activities face challenges, such as determining the relative importance of each activity and conflict of interest. Guilherme Marques, a principal investigator, shared the project's results at the II Integrated Meeting of the Paranapanema River. In addition, investigators organized a field meeting with local stakeholders from different sectors to discuss the importance of the last unimpaired Parana River Tributaries.

The team identified the response of ecosystem services to change in flow dynamics and the desired regimes. Applying the Indicators of Hydrological Alteration (IHA) method, scientists revealed that fish migration and reproduction respond strongly to four components: duration of flood events, followed by starting date, peak, and frequency. Using these components as key flow regime indices, they developed a methodology framework to investigate the scenarios with migratory fish young-of-the-year (YoY) abundance response to each different flow regime.

Finally, the researchers have advanced in the mathematical and computational modeling of the Paraná river basin hydropower system meeting both hydropower generation and ecosystems services demands. They investigated the operational and technical features of the 53 hydropower plants in the Paraná river and simulated their performance to generate hydroelectricity, applying the Stochastic Dual Dynamic Programming (SDDP) methods. The research team will couple the

model with a multi-objective evolutionary algorithm (MOEA) to analyze the trade-offs between the two demands and will feed this information into future reservoir operational policy.

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SGP-HW 091

IMPROVING THE GOVERNANCE OF THE FLOODPLAIN IN OVER-BUILT RIVER BASINS

Growing Demand for Water

Overbuilt-river basin

The research team quantified and interpreted flow dynamics of **Paraná river downstream of Porto Primavera dam**

The team has been working to understand ecological effects on large wetlands and floodplains downstream of hydropower plants governance.

"Several important socio-economic activities depend directly or indirectly on fish and their ecosystem"

Recreation | Tourism | Professional fishing

The team revealed that these activities face societal challenges, such as determining the relative importance of each activity and conflict of interest through stakeholders' discussion.

Response of ecosystem services to change in flow dynamics

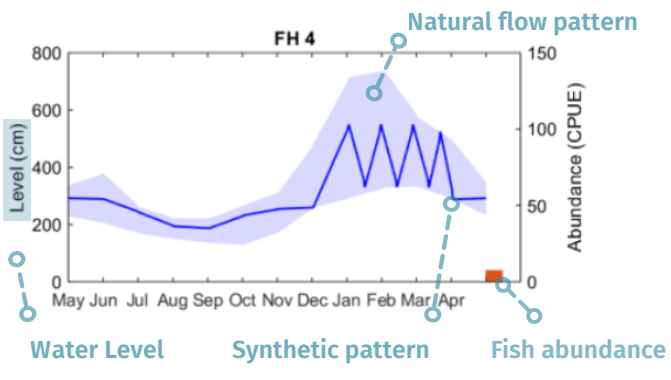
Scientists revealed that fish migration and reproduction respond strongly to four key indicators.

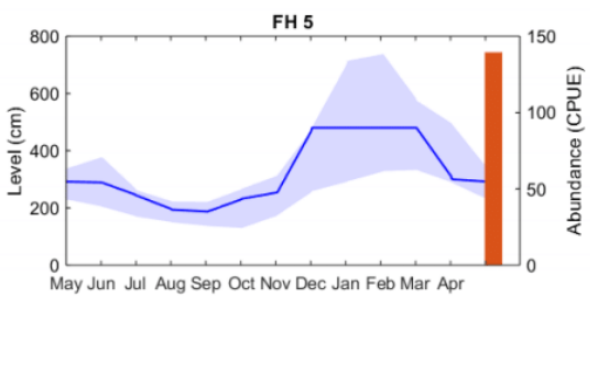
FLOW PATTERN INDICATORS

Duration, Starting date, Peak and Frequency

of flood events

Developed a methodology framework to identify desired flow pattern





- **Examples of possible scenarios**

  The abundance of migratory fish young-of-the-year (YoY) varies depending on each synthetic pattern (termed"functional flow"). Each synthetic pattern contains a different combination of natural flow regime indicators.

- **The results from six scenarios**

  (a) It is possible to obtain satisfactory fish abundance by focusing on key flow regime indicators.

  (b) More than one solution to ecosystem recovery could be found by rearranging indicators and exploring different patterns.

  (c) Some patterns should clearly be avoided, given their very low performance

Investigated technical features of the 53 hydropower plants

The team simulated their performance to optimize the basin hydropower system, meeting both hydropower generation and ecosystem services demand. They are currently working on a trade-off analysis to support the development of reservoir operating policies.