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Mainstreaming Natural Capital Assessment for Wetland Conservation in Uruguay

Final Report

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September 2026

Mainstreaming Nature in
Policy and Investment Decisions

Final Project Report
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Uruguay

Stanford Natural Capital Alliance
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Ministerio de Ambiente
Ministerio de Economía y Finanzas
IDB

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Acknowledgements

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This document outlines the activities and results of the Uruguay pilot project under the Regional Technical Cooperation (TC), "Transforming Policy and Investment Through Mainstreaming Rapid Approaches for Natural Capital Assessment and Accounting."[1] This TC was funded by the Global Environmental Facility (GEF),[2] implemented by the Inter-American Development Bank (IDB), and executed by Stanford University. The main beneficiaries and co-designers of this TC are the Ministry of the Environment (MA) and Ministry of Economy and Finance (MEF), and the technical work was led by the Natural Capital Alliance team (NatCap) at Stanford University. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the funders.

This project in Uruguay is also part of the People, Planet, Prosperity (3Ps) project, through which NatCap collaborates with IDB, ADB, and the World Bank with pilots in 16 countries, aiming to scale up the use of natural capital approaches around the world.[3]

1 **Transforming Policy and Investment Through Mainstreaming Rapid Approaches for Natural Capital Assessment and Accounting**, 2023, Inter-American Development Bank.

2 **Transforming Policy and Investment Through Mainstreaming Rapid Approaches for Natural Capital Assessment and Accounting**, 2023, Global Environmental Facility.

3 **People, Planet, Prosperity: Mainstreaming Nature in Policy & Investment Decisions (Global)**, The Natural Capital Alliance, Stanford University.

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Executive Summary

This pilot project in Uruguay was focused on producing a natural capital assessment of the country's wetlands to support the implementation and financing of the recently passed wetland conservation policy: 'Decree on the Declaration of Wetlands of Environmental Importance' (Decree No. 228/025). A technical team comprised of key ministerial staff and consultants, in close collaboration with high-level decision-makers and the Inter-American Development Bank (IDB), worked closely over the course of one year with staff at Stanford University's Natural Capital Alliance (NatCap) to design and implement an assessment and valuation of four key ecosystem services provided by wetlands to people in Uruguay.

Key Findings

Uruguay's inland wetlands generate significant economic benefits through the three ecosystem services assessed —carbon storage, flood mitigation, and water provision— with an estimated annual value of approximately USD 223 million driven primarily by carbon storage and flood mitigation. This is equivalent to a national average of USD 401/ha of wetland/year, around 3.1 times the market rental value of agricultural land in 2025.

Flood mitigation emerged as the most spatially heterogeneous ecosystem service, with high-value wetlands unevenly distributed across basins. On a per-area basis, wetlands in Río Uruguay provided the greatest flood mitigation services, followed by wetlands in Río Negro.

Across the analyzed basins, current wetland protection instruments —Decree No. 228/025 and the National System of Protected Areas (SNAP)— cover approximately 66% of total inland wetland area but only 49% of the estimated flood mitigation economic value, indicating that while protection is extensive in spatial terms, important high-value wetlands for flood risk reduction remain outside the current protection network. This relationship varies across basins: in the Río Santa Lucía basin, for example, 95% of the wetland area and 96% of the flood mitigation service value falls within the protected network. In contrast, in Laguna Merín, ~50% of the wetland area falls within protected areas, but these wetlands account for only 14% of the total estimated flood mitigation value.

Coastal wetlands currently provide significant coastal protection for almost 23% of Uruguay's coastline (158km), including nearly 25,000 people, and infrastructure valued at over USD 6.1 billion. Their protective role becomes even more significant under future sea level rise scenarios, safeguarding more than 57,000 people and infrastructure valued at USD 6.3 billion.

This report presents key results produced by the analysis, as well as a discussion on the application of these results to support implementation and financing of Decree No. 228/025.

In addition to the technical assessment, the team provided guidance on policy and finance instruments for strengthening implementation of Decree No. 228/025, including how natural capital information can support these efforts. This included identifying priority wetlands for protection and restoration, highlighting gaps in current protection coverage, proposing Key Performance Indicators (KPIs) for wetland-related financial instruments, assessing the potential of a complementary fiscal incentive, and identifying key information needs for the future development of additional conservation and finance mechanisms.

Through this technical work, the project team developed capacity among key ministerial staff, consultants, academics, and decision-makers to conduct and apply natural capital approaches to policy questions. This process strengthened institutional capacity to integrate ecosystem service information into environmental planning, policy implementation, and financing decisions in Uruguay, contributing to the country's broader goals of ecosystem resilience, climate adaptation, and inclusive sustainable development.

Introduction

In recent years, Uruguay has taken important steps toward incorporating natural capital information into a diverse array of regional and national policies – exemplified by the Río Santa Lucía Action Plan[4] and the integration of ecosystem-based approaches in its Nationally Determined Contributions (NDCs).[5] More recently, the country has advanced innovative financial instruments, such a sustainability-linked sovereign bond[6] and a sustainability-linked loan, which tie environmental performance to economic outcomes, reinforcing the role of natural capital in policy design.[7] This aligns with growing global recognition of nature as an asset underpinning human wellbeing, economic productivity, and climate resilience, and increased efforts to integrate natural capital explicitly into development planning, public policy, and economic decision-making. Natural capital approaches, including natural capital assessment and accounting, provide a framework to map, measure, and value the benefits that ecosystems provide to society, from water and food security to climate regulation and biodiversity conservation.[8,9,10] While these initiatives demonstrate Uruguay's progress towards incorporating the country's natural capital into economic and policy frameworks, further efforts are needed to strengthen the link between natural capital information and concrete planning and policy instruments. This is particularly relevant for ecosystems such as wetlands, where challenges persist, including the availability of consistent data, coordination across institutions, and the effective implementation of management and conservation measures.

> Natural capital approaches make explicit nature's benefits to people so they can be incorporated into decisions and motivate investments in ecosystems, improving the well-being of both people and nature.

4 Mvotma 2013. Plan de acción para la protección del agua en la cuenca del Santa Lucía. Montevideo, Uruguay.

5 República Oriental del Uruguay. (2024). Tercera Contribución Determinada a nivel Nacional al Acuerdo de París. Ministerio de Ambiente.

6 Ministerio de Economía y Finanzas (MEF). (2025). Uruguay 's sovereign sustainability-linked bond (SSLB) annual report.

7 Additional instruments include the CONEAT index, the Sustainable Soil Use and Management Plan policy, and a World Bank Development Policy Loan incorporating climate-linked incentives.

8 Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. HM Treasury.

9 Natural Capital Coalition. (2016). Natural Capital Protocol.

10 Millennium Ecosystem Assessment. (2005). Ecosystems and human well-being: Synthesis. Island Press.

Policy and Environmental Context

Wetlands in Uruguay: ecological importance and anthropogenic pressures. Uruguay is located entirely within the Pampa biome, where temperate grassland ecosystems predominate. The country's economy relies heavily on rural landscapes shaped by cattle ranching, agriculture, and forestry.[11] Wetlands cover ~12% of Uruguay's national territory (Figure 1).[12,13] They are widely distributed across the country and play an important role in supporting ecological functions and human wellbeing by regulating water flows for drinking and irrigation, mitigating floods[14,15], retaining nutrients and sediment, and sequestering carbon.[16,17]

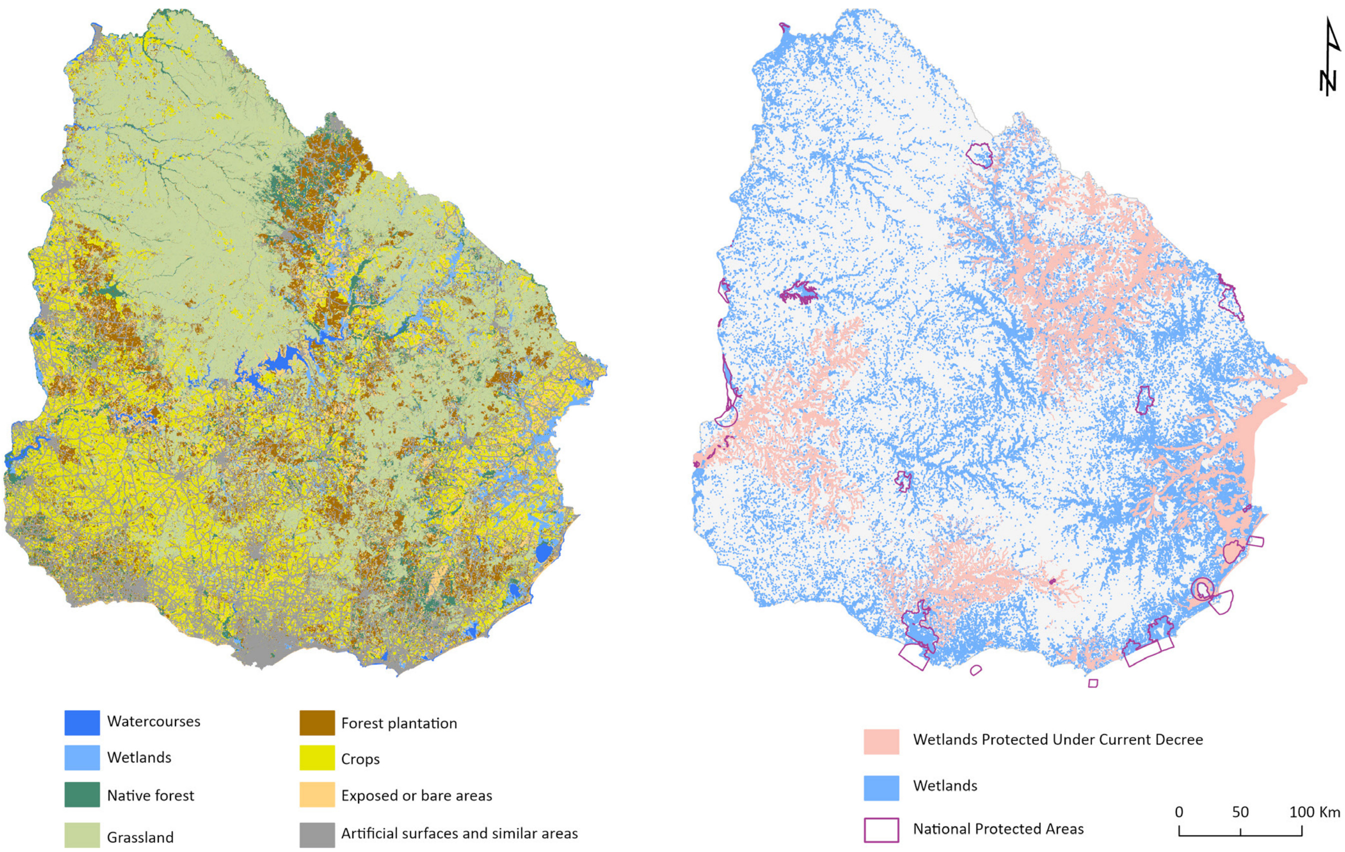


Figure 1. Land use land cover (LULC) and distribution of wetlands in Uruguay. LULC is derived from the DINOT 2022 dataset (aggregated into seven categories for visualization purposes) with the spatial distribution of wetlands, wetlands protected under Decree No.° 228/025, and protected areas within Uruguay.

11 Uruguay XXI. (2019). Uruguay, a world reference in food security.

12 Ministerio de Ambiente (MA). (2024). Día Mundial de los Humedales 2024.

13 Achkar, M., Díaz, I., & Sosa, B. (2014). *Inventario nacional de humedales del Uruguay.* Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente (MVOTMA).

14 Mitsch, W. J., & Gosselink, J. G. (2015). Wetlands (5th ed.). Wiley.

15 Millennium Ecosystem Assessment, 2005.

16 IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II contribution to the Sixth Assessment Report. Cambridge University Press.

17 Mitsch, W. J., Bernal, B., & Hernandez, M. E. (2013). Ecosystem services of wetlands. International Journal of Biodiversity Science, Ecosystem Services & Management, 9(1), 1–10.

However, wetlands have historically been treated as areas available for conversion, often being drained or modified for agricultural expansion.[18,19] Together with infrastructure development and urban expansion, these land use changes have contributed to the loss and degradation of wetland ecosystems in several regions of the country.[20] Furthermore, approximately half of the country's towns are located at least partly in wetland areas, illustrating the close spatial interaction between urban development and these ecosystems and increasing both ecosystem degradation and the exposure of populations to flood risk.[21] These trends highlight the need for improved policy instruments and decision-making tools to ensure their conservation and sustainable management.

Current Regulatory Framework for Wetland Protection. From a broad national context, wetland conservation is embedded across multiple policy frameworks and contributes directly to their implementation, including the National Biodiversity Strategy, the National Water Policy, the National System of Protected Areas, the National Environmental Plan, and other related instruments such as Río Santa Lucía and Río Negro Basin Plans and NDCs.

In 2018, Uruguay amended the Water Code (Law No. 14.859, Article 159) by introducing a new provision establishing the protection of wetlands.[22] This amendment defined wetland conservation as a matter of public interest and established a general legal framework for the protection of wetlands, including a prohibition on drainage, desiccation, or similar interventions in wetlands of environmental importance.[23] It did not, however, specify the spatial scope, operational criteria, or enforcement mechanisms required for its implementation. In 2025, the Executive Branch approved the Decree on the Declaration of Wetlands of Environmental Importance (Decree No. 228/025), which introduced a regulatory framework for the implementation and operationalization of the aforementioned article. The new Decree establishes the basis for the protection of an area of approximately 800,000 hectares, encompassing wetlands distributed across four major basins: the Río de la Plata Basin, the Laguna Merín and Atlantic Ocean Basin, the Río Santa Lucía Basin, and the Río Negro Basin (Figure 1). The delineation of the protected wetland areas was determined by the Ministry of Environment. The designation of priority wetlands was based on their extent, proximity to urban centers, and species richness. In this context, incorporating an ecosystem services perspective could complement the prioritization process by providing a more comprehensive understanding of the societal value of wetland protection, while also helping to identify potential gaps in the current policy framework.

To contribute to this effort, the pilot project created an inter-institutional technical team, comprised of staff from the Ministry of the Environment – DINABISE (Biodiversity and Ecosystem Services) and DINACC (Climate Change) directorates, the Ministry of Economy and Finance, a spatial analyst consultant, a project management and economic valuation consultant and the Stanford-based Natural Capital Alliance (including a hydrologist, engagement lead, student intern, and GIS analyst). The team conducted an ecosystem service assessment and valuation of wetlands in Uruguay, with the end goals of supporting implementation of the Decree and building capacity among technical staff and decision-makers to conduct and apply natural capital approaches.

Additionally, implementing the Decree entails challenges in terms of monitoring and enforcement

18 Achkar et al., 2014 Op. Cit.

19 Schön, F., Domínguez, A., & Achkar, M. (2022). Urban wetlands, their dynamics and management strategies from the perspective of Environmental Geography. *The Geographical Journal*, 188, 415–428.

20 Ministerio de Ambiente (MA). (2024). *Informe del estado del ambiente en Uruguay 2020–2022*. Montevideo: Ministerio de Ambiente, República Oriental del Uruguay.

21 Schön, F., Domínguez, A., & Achkar, M. (2018). Distribución territorial de áreas urbanas en zonas de humedales en Uruguay. *Geo UERJ*, 33, 1–25.

22 Uruguay. (2018). Ley N° 19.670: Rendición de cuentas y balance de ejecución presupuestal. Ejercicio 2017. IMPO.

23 Article 159 explicitly prohibits drainage, desiccation, or similar interventions in wetlands that are declared to be of 'environmental importance' based on their size, location relative to urban centers, or ecological relevance.

capacity, and will require the development of complementary regulatory and economic instruments. To address this, the pilot project incorporated contributions and strategic input from the Ministry of Economy and Finance to ensure that the science and economic valuation of wetlands in Uruguay can directly help develop economic instruments to sustain their protection.

Glossary of Key Terms

Beneficiaries: The specific people, groups, sectors, or organizations that receive ecosystem services. More specifically, these are all the socioeconomic units that benefit from ecosystem services.[24]

Wetlands: Wetlands are ecosystems in which water is the primary factor controlling environmental conditions and the associated plant and animal communities. They occur where the water table is at or near the land surface, or where the land is permanently or temporarily inundated. According to the Ramsar Convention, wetlands include areas of marsh, fen, peatland, or water (natural or artificial, permanent or temporary) with water that may be static or flowing, fresh, brackish, or saline, including marine areas with a depth of up to six meters at low tide.[25]

Ecosystem services: Refers to the material, spiritual, cultural, communal, and other benefits that ecosystems provide to people. Formally, it refers to "the contributions of ecosystems to the benefits that are used in economic and other human activity."[26]

Natural capital: The Earth's natural assets – its lands, waters, and biodiversity – upon which all life depends.[27,28,29]

Natural capital approaches: Approaches that make explicit nature's benefits to people so they can be incorporated into decisions and can motivate investments in ecosystems, improving the well-being of both people and nature. This includes both natural capital assessments and accounting.

Natural capital assessments: Through close engagement with decision-makers, local experts, and stakeholders, natural capital assessments quantify and map both natural capital stocks (e.g., water-purifying wetlands) and the ecosystem services flowing to people (e.g., safe drinking water) to provide quantifiable – and often, spatially explicit – metrics of those services, whether monetary, biophysical, or social/cultural.

Economic valuation: A component of many natural capital assessments and accounting focused on providing estimates of values for the relevant ecosystem services, expressed in monetary or non-monetary units to enable comparison across diverse benefits and costs.[30] In the environmental context, it includes both market and non-market values, reflecting the wide range of benefits derived from natural

24 See Systems of Environmental-Economic Accounting – Ecosystems Accounting, United Nations, 2024, p. 140.

25 Ramsar Convention Secretariat. (2016). An introduction to the Convention on Wetlands (previously The Ramsar Convention Manual) (5th ed.). Ramsar Convention Secretariat, Gland, Switzerland.

26 See Systems of Environmental-Economic Accounting – Ecosystems Accounting, United Nations, 2024, p.31

27 Barbier, E. B. (2019). The concept of natural capital. Oxford Review of Economic Policy, 35(1), 14–36.

28 Costanza, R. (2020). Valuing natural capital and ecosystem services toward the goals of efficiency, fairness, and sustainability. Ecosystem Services, 43, 101096.

29 Bateman, I. J., & Mace, G. M. (2020). The natural capital framework for sustainably efficient and equitable decision making. Nature Sustainability.

30 Bateman & Mace, 2020. *Op. Cit.*

capital.[31,32] Economic valuation provides a common metric to assess tradeoffs and support decision-making by making explicit the benefits and costs associated with alternative actions.[33,34]

Opportunity cost: refers to the value of the best alternative forgone when a decision is made. It represents the benefits that are lost when land, resources, or investments are allocated to one use instead of another. Considering opportunity costs is essential for evaluating tradeoffs, as decisions about conservation, restoration, or development inherently involve choosing between competing uses of natural capital and their associated benefits.

Key performance indicators (KPIs): predefined, quantifiable metrics that track an issuer's progress toward specific sustainability performance targets (SPTs).

Process and Methodology

This section describes the overall methodological approach, scope of work, and structure of the project. The initiative was designed to support the integration of natural capital assessments into wetland management and policy development in Uruguay through a combination of technical analysis, capacity building, and institutional engagement. Comprehensive technical methods and results for the project are detailed in Appendix A, "**Technical Appendix: Mainstreaming Natural Capital Assessment for Wetland Conservation in Uruguay**," which is meant to be a companion to this report.

Engagement and capacity development: methods

Project engagement was structured around the project's three key objectives:

To support the implementation of Uruguay's wetland protection Decree No. 228/025 by conducting a natural capital assessment of wetlands, quantifying key ecosystem services such as flood mitigation, water provisioning, coastal protection, and carbon storage in biophysical and economic terms – and through this pilot to generate evidence for natural capital approaches to inform policy and finance decisions in Uruguay more broadly.

To strengthen technical capacities to apply natural capital approaches through in-depth training of a core technical team, complemented by broader training activities for government staff, practitioners, academics, and other stakeholders. The training was closely linked to the pilot, ensuring that capacity is built through direct application of tools and methods.

To promote inter-institutional coordination and policy innovation through the establishment of an advisory council composed of representatives from key ministries. This platform facilitated dialogue between technical and policy actors and ensured alignment between analytical outputs and policy priorities.

31 Costanza, 2020. *Op. Cit.*
32 Guerry et al., 2015. *Op. Cit.*
33 Bateman & Mace, 2020. *Op. Cit.*
34 Barbier, 2019. *Op. Cit.*

These three components were implemented in an integrated manner, ensuring that technical results were both policy-relevant and institutionally embedded. Figure 2 summarizes the overarching vision for the pilot, key activities, and policy goals. Table 1 describes the key partners involved in the pilot, and their roles and responsibilities.

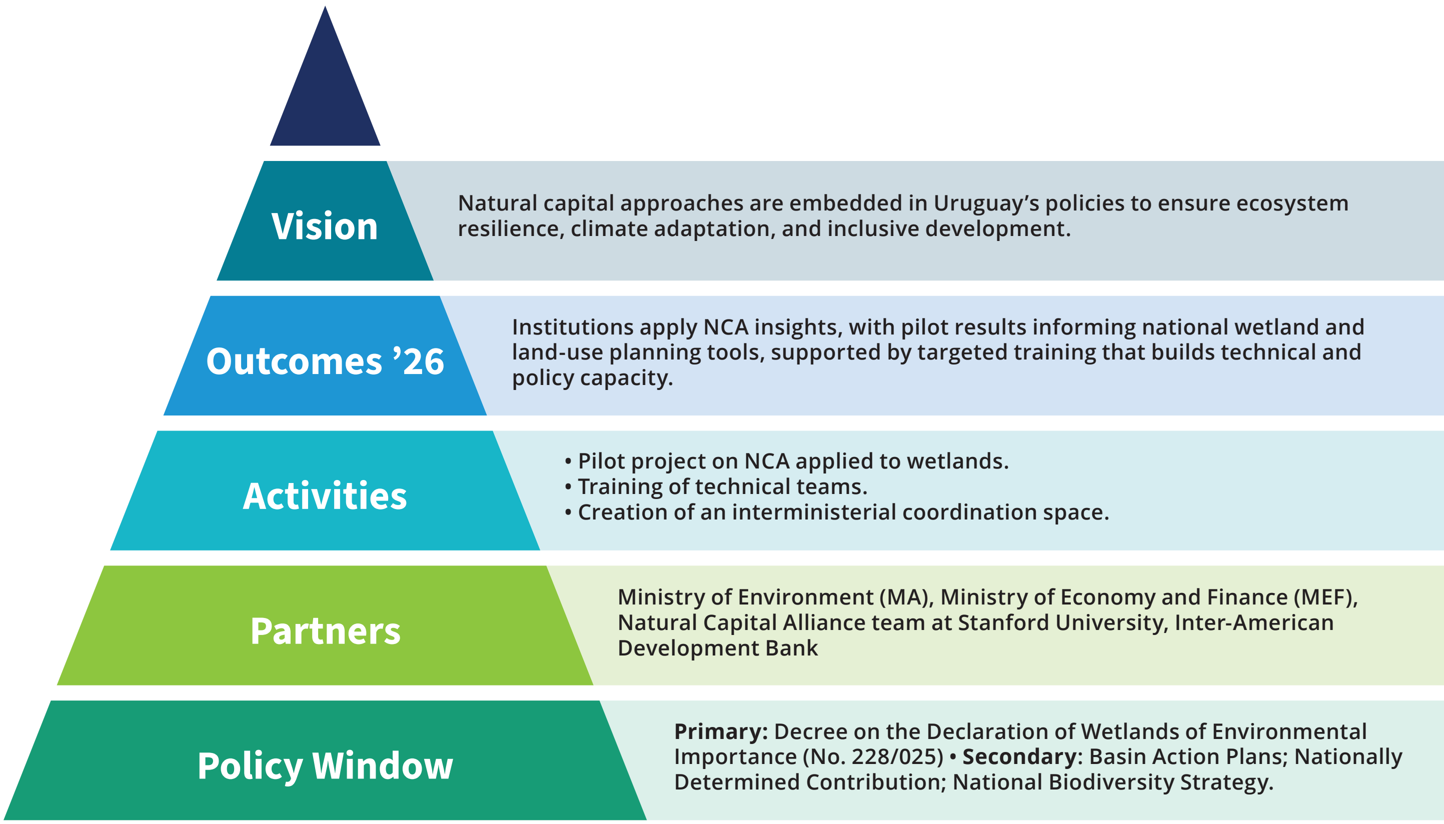


Figure 2. Theory of change for mainstreaming natural capital assessment into ecosystem-related policies in Uruguay, illustrating the link between policy windows, partnerships, activities, outcomes, and long-term vision.

Table 1. Key partners, roles and responsibilities in Uruguay pilot.

Key Partners	Roles and Responsibilities
Core technical team • Biodiversity and Ecosystem Services Directorate (DINABISE) & Climate Change Directorate (DINACC) – Ministry of Environment (MA) • Ministry of Economy and Finance (MEF) • External consultants (economic valuation, GIS/spatial analysis) • Stanford Natural Capital Alliance team (Hydrologist, GIS Analyst, Engagement Lead, Student Intern with the EPIC program) • Inter-American Development Bank (IDB) (country and regional teams)	• Conduct an ecosystem service assessment and valuation for 4 key wetland ecosystem services including pre-processing data, running InVEST models, post-processing outputs, developing and communicating results. • Produce policy and finance instruments pathways/ options. • Participate in regular technical meetings over 16 months with NatCap staff to conduct and refine an ES assessment. • Participate in a week-long working group intensive at Stanford. • Provide strategic and technical guidance for the pilot through bi-weekly coordination meetings over 16 months. • Ensure coordination across workstreams and alignment with project objectives.
Advisory Council Directors from key government directorates: • DINABISE & DINACC - MA • Economic Policy Directorate - MEF. • Land Planning Directorate (DINOT)- Ministry of Land Planning (MVOT). • Office of Agricultural Programming and Policy (OPYPA) & Natural Resources Directorate (DGRN) - Ministry of Livestock, Agriculture and Fisheries (MGAP).	• Provide high-level policy guidance and ensure alignment with national priorities during three 2-hour meetings. • Facilitate interinstitutional coordination and support policy uptake. • Validate key results and recommendations at strategic stages.

Technical analysis: methods

The technical analysis of the pilot project was designed to address three main questions important for guiding the implementation and financing of Uruguay's wetland policy:

What is the value of the ecosystem services provided by all wetlands in Uruguay?

How is the economic value of ecosystem services distributed between protected and unprotected wetlands?

How can this information be used to inform policy and finance instruments to support the conservation and sustainable management of wetlands?

Methods for modeling and mapping wetland ecosystem services. To map and measure the ecosystem services provided by wetlands in Uruguay, the team used InVEST® software,[35] an open-source suite of models created by the Natural Capital Alliance for measuring and mapping ecosystem services, to model wetlands' provision of four key ecosystem services: flood risk mitigation, surface water provision for human consumption and agriculture, climate change mitigation (carbon storage), and coastal protection.

For freshwater-related services (e.g. flood risk mitigation and water provision) a hybrid modeling framework was applied that combines the InVEST Seasonal Water Yield (SWY) model with a novel hydrological routing methodology that explicitly captures the role of wetlands in water storage, regulation, and flow dynamics across the landscape by comparing routed flows magnitudes under current wetland storage conditions with routed flows under a no-wetlands scenario, representing the removal of wetland storage and regulation from the hydrological system (typically as a result of, for instance, draining or filling).[36]

Comprehensive methods detailing all steps of the technical process including the definition of policy-relevant objectives, selection of services, compilation of spatial data, and model parameterization, calibration, and validation are included in **Appendix A**. See below for overviews of certain methods and analyses.

Importantly, wetlands are difficult ecosystems to map give their ephemeral nature, and there are differences in the delineation of wetland areas among land-use/land-cover (LULC) layers produced by different ministries in the country. Because the LULC layer is such a critical input to the models, the team evaluated available alternatives produced by the National Directorate of Land Use Planning – Ministry of Housing and Land Use Planning (DINOT–MVOT), Ministry of Livestock, Agriculture and Fisheries (MGAP), Ministry of Environment (MA), and MapBiomas Uruguay. After evaluation and consultation with the Advisory Council, the LULC layer developed by DINOT–MVOT was selected as the common baseline for all scenarios (Figure 1). The main criteria supporting this decision were that it is the official dataset used in land-use planning, has a 10 m resolution providing adequate levels of detail for national analyses, includes classes that represent wetlands, has undergone recent updates and classification accuracy is close to 90%, and finally there is broad institutional acceptance, which facilitates its application in public policies.

Lastly, modeling was done at multiple spatial scales to account for differences in data availability and policy demands: coastal protection was modeled for the Uruguay coastline and focused on coastal wetlands; carbon sequestration was modeled for inland wetlands at the national scale; and flood risk mitigation and water provisioning were both modeled for the four main inland basins across the country (Figure 3).


Photo credit: Uruguay Ministry of Environment

35 **InVEST: Integrated Valuation of Ecosystem Services and Tradeoffs**, Natural Capital Alliance, Stanford University

36 This wetland-focused workflow was developed by NatCap scientist H. Angarita and research assistant and EPIC Program intern T. Ramsay in response to limitations of the existing InVEST SWY model as it relates to wetlands.

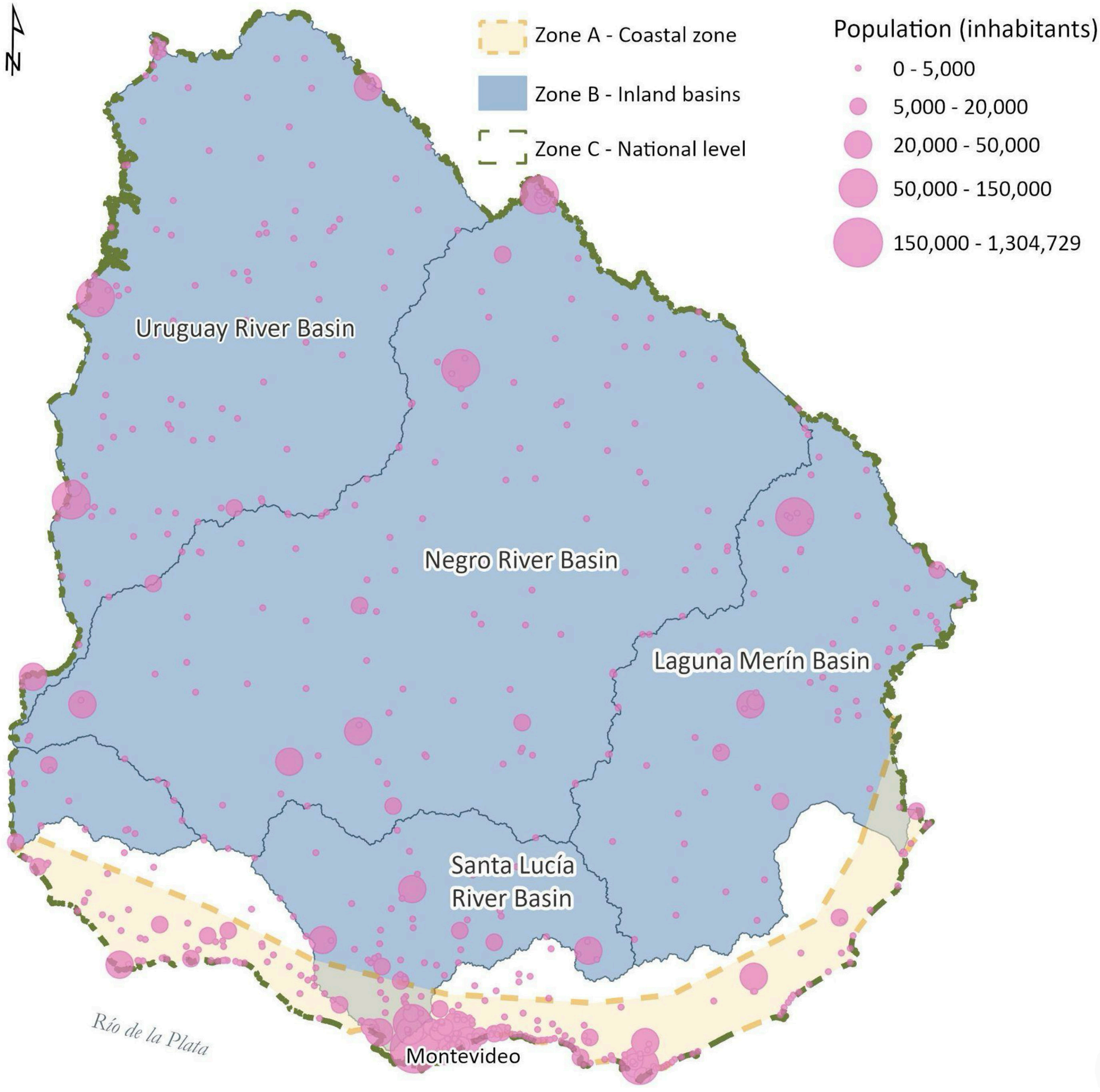


Figure 3. Spatial scope of pilot project analysis. The InVEST Coastal Vulnerability model was run for the coastal region focusing on coastal wetlands (Zone A). The InVEST Seasonal Water Yield and Carbon models focused on inland freshwater wetlands - and were run for four main river basins (Zone B) and at a national scale (Zone C) respectively. Population is shown with proportional symbols (inhabitants).

Example: methods for valuation of wetland ecosystem services, flood mitigation service. Wetland ecosystem services were valued in both monetary and non-monetary terms. Figure 4 shows the general workflow for modeling, mapping, and valuing ecosystem services, using flood mitigation service as an example. Following the biophysical modeling of ecosystem service supply, subsequent steps to value the service included identifying beneficiaries and selecting an appropriate valuation approach. Table 2 briefly describes the valuation approaches, key beneficiaries, and assumptions for each service.

These valuation approaches should be interpreted as indicators of the social and economic relevance of wetland conservation and restoration, rather than as a direct assignment of individual ecosystem service values to specific interventions. They help establish the rationale for action by identifying the types of benefits generated, the beneficiaries involved, and the relative importance of different ecosystem services and wetlands in different areas of the landscape. An in-depth methodological justification for valuation can be found in Appendix A.

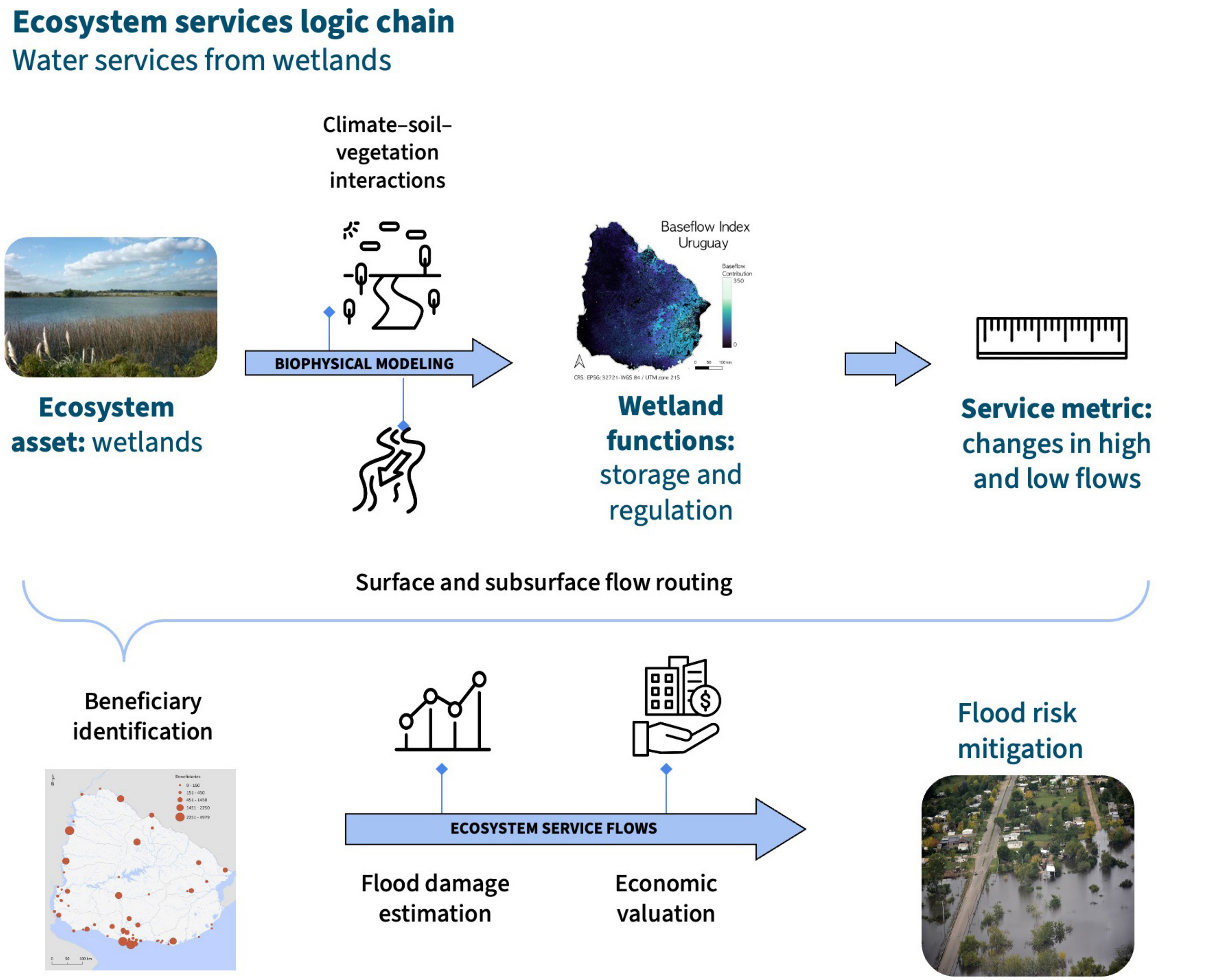


Figure 4. Valuation of ecosystem services logic chain. Example workflow for biophysical modeling and economic valuation of ecosystem services, in this case using flood mitigation services and the InVEST Seasonal Water Yield model as an example.

Table 2. Overview of ecosystem service valuation methods, beneficiaries, and key assumptions.

Ecosystem service	Beneficiaries	Valuation approach
Flood mitigation	Urban households, infrastructure, public sector	**Benefit transfer – hedonic pricing:** value inferred from another study showing how flood risk affects property prices.
Surface water provision	Households, water utilities and industries	**Replacement cost:** value estimated as the cost that would be required to supply an equivalent water volume through alternative infrastructure.
Surface water provision – agriculture	Farmers, agricultural sector	**Shadow price of water[37]:** estimates the loss in agricultural production value associated with one less unit of water, such as 1 m³.
Climate change mitigation	Global society, public sector	**Social Cost of Carbon:** values carbon sequestration based on the avoided marginal damages from CO_2 emissions, including impacts on property, infrastructure, agricultural productivity, water resources, human health, and well-being.
Coastal protection	Coastal population and property	**Asset exposure-based prioritization[38]:** identifies people and property located within 1 km of the coast as potentially exposed to coastal hazards.

While valuation approaches for each ecosystem service are detailed in depth in Appendix A, this section provides an example of the team's approach to valuing flood mitigation services provided by inland wetlands in four major basins: Río Uruguay, Río Negro, Laguna Merín, and Río Santa Lucía. To value flood mitigation, a flood damage function was developed using 30 years of historical hydrometric data (years 1984–2013) combined with records of households affected by flood events (for the same period).[39] This approach allows for identifying an empirical relationship between river streamflow magnitude and frequency and the reported number of households exposed to flooding. To translate these impacts into economic terms, a benefit transfer approach was applied using results from a hedonic pricing study that estimated differences in property values between flood-prone and non-flood-prone areas.[40] Specifically, the economic impact per affected household was estimated as the reduction in property value associated with being located in a flood-prone area, relative to comparable properties not exposed to flood risk. Consequently, the value of wetlands is obtained through their contribution to reducing flood exposure and associated economic losses: wetlands that attenuate streamflow and reduce the number of households exposed to flooding generate higher avoided losses in property values, and therefore higher estimated ecosystem service values.

37 Shadow price refers to the implicit economic value of water as a production input, reflecting its marginal contribution to agricultural output under given scarcity and production conditions. This differs from replacement cost, which estimates the cost of providing an equivalent water supply through alternative infrastructure.

38 This approach does not estimate welfare impacts or avoided damage values. It is used as a spatial prioritization method to identify areas where coastal protection benefits may be more relevant due to the presence of exposed people and assets.

39 DesInventar Sendai. (n.d.). DesInventar database: Uruguay country profile (1959–2014). Retrieved April 2026.y

40 IDB, MEF & IMM. (2018). *Evaluación socioeconómica ex post del Programa de Ampliación y Mejora del Sistema de Drenaje y Saneamiento de Montevideo (UR-L1069)*. Internal report.

Project team visiting water treatment plant.
Photo courtesy of Guillermo Sena.

To spatially allocate economic values of flood mitigation services to the sub-basin 'micro-watershed' scale, beneficiary locations were identified and their vulnerability characterized based on the number of households exposed to flood risk. Thus, results at the micro-watershed level are a combination of (i) the economic valuation results, (ii) the spatial distribution of beneficiaries and their vulnerability, and (iii) the modeled ecosystem service supply (e.g. flood mitigation in this example) (see Figure 6).

Policy and financial instruments for wetland conservation: methods

Lastly, the assessment aimed to provide guidance on how the ecosystem services assessment and valuation could help to inform policy, development planning guidance and finance instruments supporting wetland conservation and building resilience to climate and coastal risks. This included exploring the potential to incorporate wetlands into environmental and sustainability-linked financial instruments through the definition of KPIs, as well as assessing the feasibility of economic incentives for conservation—particularly a rural property tax exemption scheme drawing on existing policy framework for native forest. Finally, the analysis identified a broader set of complementary instruments that could be developed based on the project's results.

Credit: Uruguay Ministry of Environment.

Technical Results

This section shares analytical results produced by the technical team during the pilot. Mapping, modeling and valuation of ecosystem services provided by inland wetlands is presented first, followed by coastal wetlands. Comprehensive technical results for the pilot, including methods, results for the prioritization of ecosystem services, scenario creation, modeling, mapping, and valuation of key ecosystem services are provided in the companion technical report, **Appendix A**.

Modeling and mapping ecosystem services provided by inland wetlands

Carbon sequestration provided by inland wetlands was based primarily on carbon storage associated with soil and biomass. In this analysis, due to data limitations, a single soil carbon value was applied to all wetlands and thus the delivery of carbon sequestration services was distributed relatively uniformly across wetlands and closely followed the spatial extent of wetland areas (Figure 5a).

In contrast, flood mitigation services provided by inland wetlands varies substantially across basins, a result of differences in (i) the abundance and spatial configuration of wetlands (e.g. upstream or downstream in the river network), (ii) their hydrological functioning—notably water storage and connectivity that slows runoff transit and attenuates flood peaks—and (iii) the location and vulnerability of exposed beneficiaries downstream. In this context, wetlands reduce flood risk primarily by temporarily storing floodwaters and delaying their release, which lowers and spreads peak flows over time. Figure 5b maps the marginal contribution of wetlands to peak-flow attenuation, with strong spatial contrasts within and across basins. For instance, in the Río Negro basin, the largest flood mitigation contributions are concentrated in the upper basin, consistent with wetlands intercepting and storing upstream runoff before it accumulates downstream. In contrast, in Laguna Merín and Río Santa Lucía, the strongest contributions are associated with wetlands located in lower basin areas, where their proximity to flood-prone floodplains and exposed settlements increases the extent to which local storage and flow buffering translate into avoided damages.

Similarly, we focused on wetlands' influence on low-flow dynamics at the basin scale through two main mechanisms. First, wetlands' storage and hydrological connectivity can slow down upstream runoff, attenuating flow variability and potentially supporting downstream discharge during dry conditions by releasing part of the water stored during wet periods later in the season. However, by prolonging surface water occurrence, wetlands can increase evaporation (and evapotranspiration), which may reduce total water downstream, especially under high evaporative demand. The net effect of these two processes is strongly conditioned by local factors, including wetland storage capacity, its dynamic interaction with upstream inflows, and the magnitude and timing of evapotranspiration deficits. In some cases —often associated with larger and more connected water bodies—the slowing-down mechanism dominates, producing a net increase (or maintenance) of low flows. In other cases, additional evaporation offsets or reverses that benefit, leading to an overall reduction in downstream discharge during dry periods. Because these processes are dynamically linked, the same wetland may increase low flows in some years and decrease them in others, depending on the rate and magnitude of seasonal transitions between wet and dry conditions. The analysis addressed this ambiguity by characterizing the net effect of upstream wetlands on river discharge under a range of hydrological conditions. The team evaluated compounded wetland effects across a range of hydrological states (years corresponding to percentiles 90%, 80%, 50%, 20% and 10% of average annual precipitation), and linked these effects of wetlands to the spatial distribution and intensity of water demand, considering the relative location of users with respect to wetlands. In other words, given Uruguay's hydroclimatic variability, what is the net effect of inland wetlands on water supplies where water users are located, and can wetlands reduce water availability for some downstream users under dry and very dry conditions?

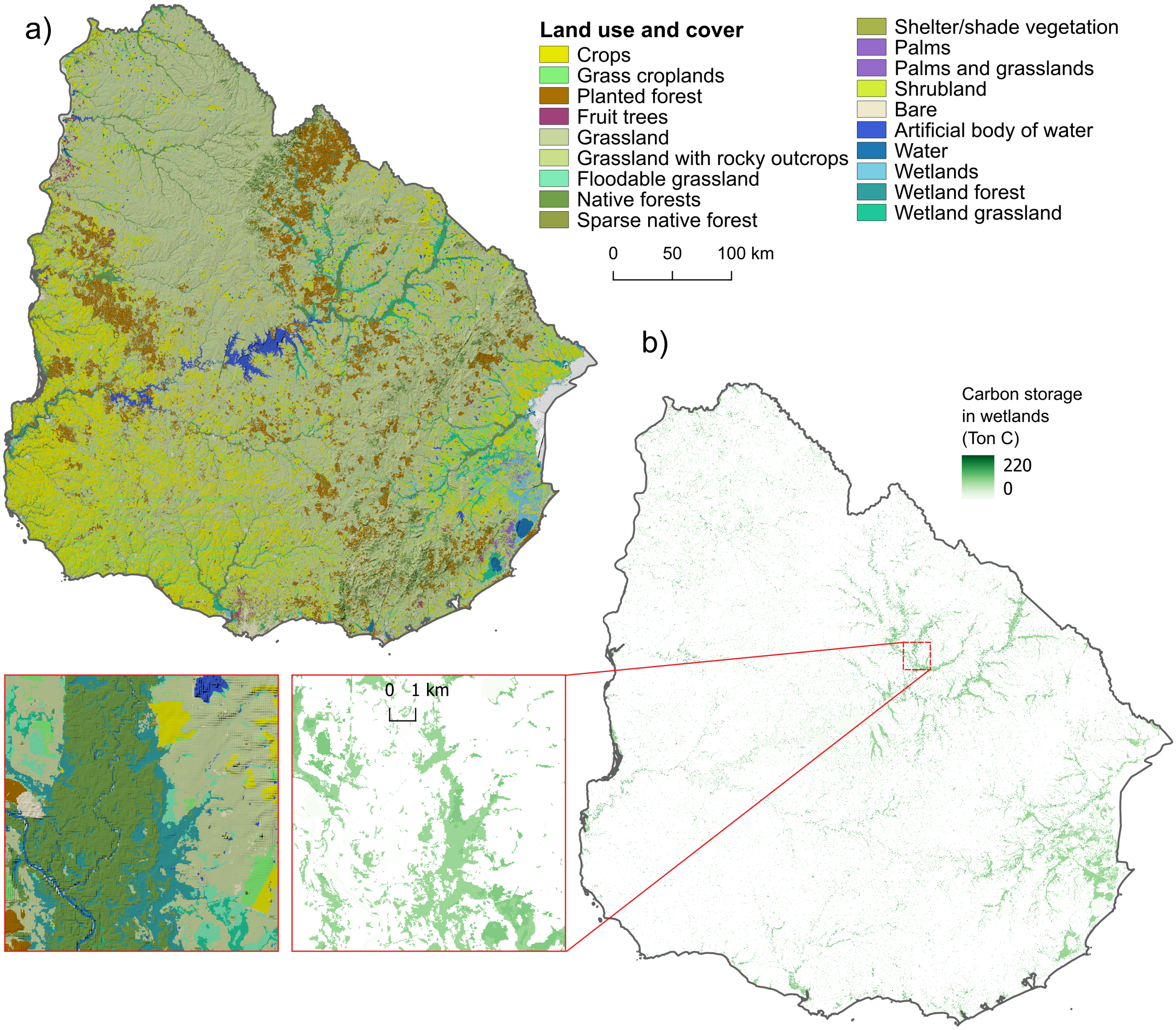


Figure 5a. Land use and supply of carbon storage and sequestration ecosystem services provided by inland wetlands in Uruguay. Ecosystem services were modeled using the InVEST suite of open-source models (see continuation of figure in 5b).

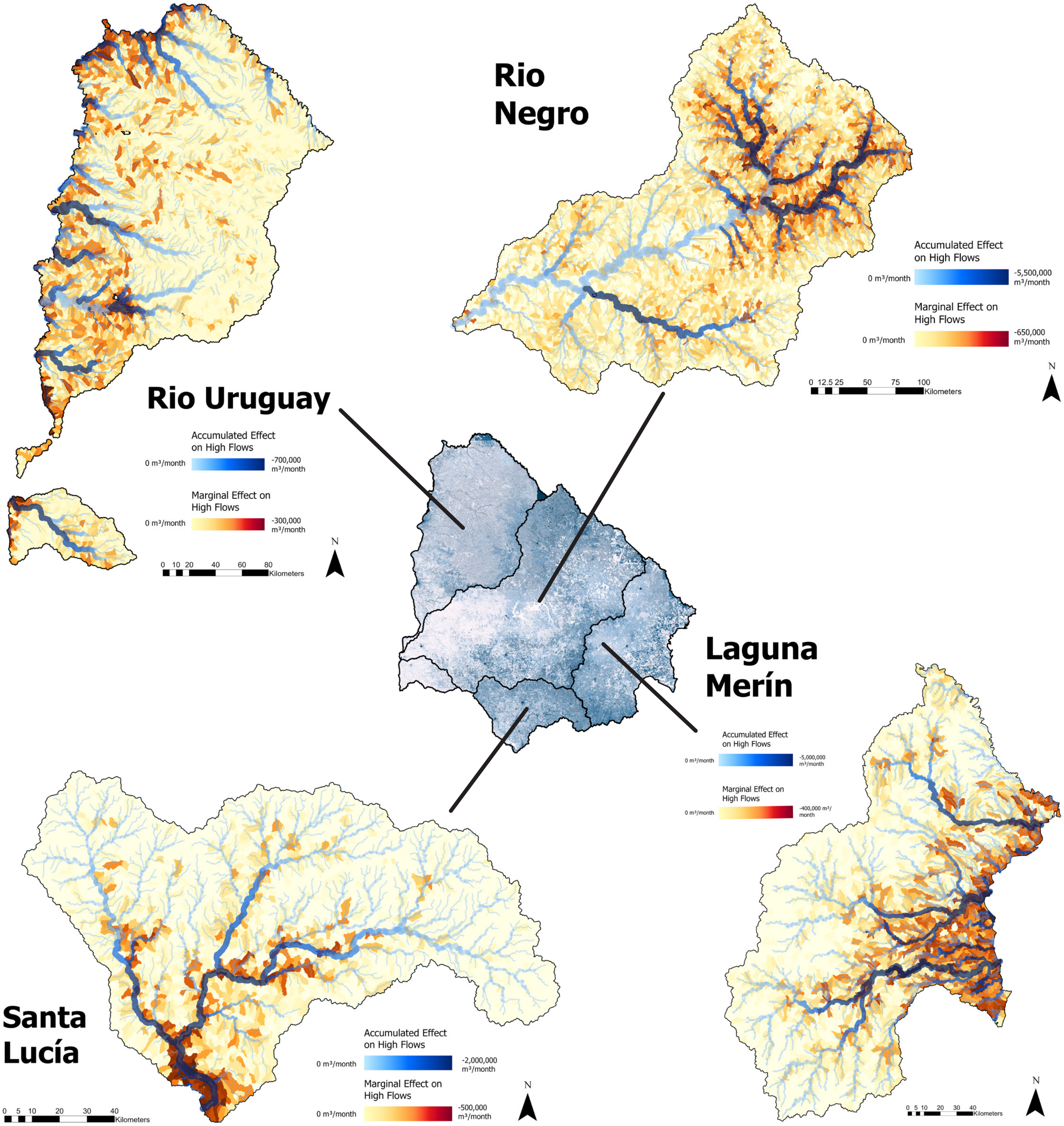


Figure 5b (continued). Flood mitigation services provided by wetlands in the four main inland basins of Uruguay expressed as the marginal effect of wetlands on peak flow attenuation at the micro-watershed level (brown scale), the changes in monthly water volume (m³/month), and the aggregated downstream effect on peak high flows (blue scale). Negative values indicate a reduction in flow associated with the presence of wetlands, translating to a greater potential mitigation of flood hazards to downstream beneficiaries.

Valuation of ecosystem services provided by inland wetlands

Table 3 presents the aggregated economic value of ecosystem services provided by inland wetlands for the main river basins in Uruguay. The results demonstrate that these wetlands provide a net positive contribution to social welfare when considering the combined value of the three ecosystem services assessed. In annual terms, the total economic value amounts to approximately USD 223 million, equivalent to an average of USD 401/ha of wetland/year. This represents around 3.1 times the market rental value of agricultural land in 2025. For the water regulation model, the Río de la Plata and Atlántica basins were excluded from the valuation, as no significant relationship was identified in the flood damage curves given the available data and model assumptions. The results also show variation in value per hectare across basins (ranging from USD 368 to USD 481/ha/year). This is largely driven by differences in the contribution of flood risk mitigation services across basins, leading to higher values in basins where wetlands play a stronger role in attenuating flood impacts. Río Uruguay basin, in particular, has the highest value per hectare of wetland at USD 481/ha/year.

Table 3. Annual economic value of inland wetland ecosystem services by basin.

Basin	Annual economic value by ecosystem service					
	Flood risk mitigation (USD/yr)	Water provision (USD/yr)	Carbon storage (USD/yr)	Overall economic value (USD/yr)	Wetland area (ha)	Average economic value (USD/yr/ha)
Santa Lucía	$675,938	-$128,201	$8,067,195	$8,067,195	21,950	$387
Río Negro	$11,195,209	-$112,199	$68,749,335	$68,749,335	187,061	$427
Laguna Merín	$4,967,421	-$1,431,506	$75,250,165	$75,250,165	204,750	$385
Río Uruguay	$2,949,560	$679,057	$11,753,295	$11,753,295	31,980	$481
Río de la Plata	NA	NA	$5,625,132	$5,625,132	15,306	$368
Atlántica	NA	NA	$34,785,147	$34,785,147	94,648	$368
			TOTAL			AVERAGE
	$19,788,128	**-$992,848**	**$204,230,269**	**$204,230,269**	**555,695**	**$401**

Carbon storage accounts for the largest share of the total aggregated value, highlighting the role of wetlands as effective carbon sinks. Estimated carbon sequestration ranges between 954,000 and 2,616,000 tons per year, representing approximately 13–35% of the country's annual greenhouse gas emissions. Carbon storage is related to the total area of wetland, and as such, basins with greater wetland area such as Laguna Merín have higher total values for carbon storage.

Flood risk mitigation is the second-highest value service, with an estimated value of around USD 20 million per year. This reflects the crucial contribution of wetlands in mitigating flood impacts, avoiding damages to an estimated 1,147 houses during flood events. The magnitude of this service varies across basins, driven by basin-specific relationships between wetland location and locations of exposed and vulnerable assets and populations, as captured in damage functions derived from 30 years of historical data. At a more fundamental level, these functions reflect the interaction between local hydrological processes—such as infiltration, lateral connectivity, subsurface storage, and the spatial distribution of wetlands—and the characteristics of exposed populations, including population size, the location of settlements relative to watercourses, and their vulnerability to flooding. For example, the Río Negro basin has a smaller wetland footprint (roughly 10% less) than Laguna Merín, yet provides more than twice the flood mitigation benefits. This pattern reflects higher exposure (around 25% more vulnerable households), distinct hydrological dynamics, and the importance of the relative locations of wetlands in the basin.

In contrast to carbon storage and flood risk mitigation, the water provisioning (low-flow maintenance) service provided by inland wetlands shows a small net negative value at the national level (under USD 1 million per year). This result reflects the fact that wetlands can either increase or decrease downstream low flows, depending on how two coupled hydrological processes play out locally—and on where water users are located relative to wetlands.

Using the Uruguay Hydrological Information System,[41] the team assessed the effects of wetlands on 3,431 water users. Water consumption is concentrated in Laguna Merín (38%), followed by Río Negro (24%), Río Uruguay (23%), and Río Santa Lucía (16%). Combining hydrological responses with demand location, results indicate highly heterogeneous outcomes at the user level: about 36% of users benefit, 55% are negatively affected, and 9% show no significant change relative to a no-wetlands scenario. This heterogeneity explains why the national aggregate is small: wetlands simultaneously generate localized gains (via flow regulation and delayed release) and losses (via increased evaporation), and the sign of the economic effect depends on whether beneficiaries are situated where gains or reductions occur.

It is important to highlight that aggregated by basin, the estimated monetary effect of wetlands on water provisioning is small not only in absolute terms, but also relative to total water demand. Río Santa Lucía shows a net value of −USD 142,866/yr (about −USD 6.51/ha/yr), equivalent to roughly a −0.5% change relative to total basin demand. Río Negro is similarly small at −USD 112,199/yr (−USD 0.60/ha/yr; −0.5% of demand). Laguna Merín has the largest net negative value (−USD 1,431,506/yr, −USD 6.99/ha/yr), yet this still corresponds to only about a −3.9% effect relative to total water demand in that basin. In contrast, Río Uruguay shows a net positive value of USD 679,057/yr (USD 21.23/ha/yr), around +1.3% relative to total demand. The dominant driver of both positive and negative patterns is agricultural (irrigation) water use downstream of wetlands: in Río Uruguay, agriculture accounts for roughly 95% of the positive value, while in Laguna Merín, impacts on irrigation explain about 91% of the negative value.

These results indicate that—even where negative—the modeled wetland effect on low-flow water availability represents a small fraction of total water use, with the sign and magnitude driven by local hydrology and the spatial distribution of downstream users.

Finally, it is important to note that the same wetland processes that may reduce low-flow availability for some users (retention and flow regulation, coupled with increased evaporation) are also fundamental to the flood mitigation benefits discussed earlier. The results, therefore, make visible—quantitatively and spatially—the tradeoffs among ecosystem services for different sectors, which is essential for designing targeted instruments that address those disparities.

Flood mitigation service and wetland protected status

The analysis also looked at how wetland protection intersected with ecosystem service value, to understand where high-value wetlands were protected by current instruments (Decree No. 228/025 and the National System of Protected Areas (SNAP)) and where

41 DINAGUA (n.d.) Hydrological Information System (SIH). Ministry of Environment of Uruguay. (Accessed: October 2025).

they were not protected. Figure 6a shows the spatial distribution of inland wetland economic value for flood reduction (USD/ha) across the analyzed basins, while Figure 6b summarizes the percentage of wetland area currently protected in each basin and the proportion of total flood mitigation economic value represented by those protected wetlands.

The results reveal marked spatial differences in the relationship between wetland protection and flood mitigation service value across basins. Río Santa Lucía (also see Figure 7a & b) has the highest extent of wetland protection in the country – protecting 96% of the wetland area in the basin, and 95% of the flood risk mitigation value. In Río Negro basin, approximately 75% of wetland area and 71% of the estimated flood mitigation value are currently located within protected areas, indicating that existing protection instruments cover a substantial proportion of wetlands delivering flood regulation benefits. However, some high-value wetlands remain outside protected areas, highlighting protection gaps.

Laguna Merín and Río Uruguay basins present a contrasting pattern. In Laguna Merín approximately 49% of wetland area falls within protected areas, but these wetlands account for only 14% of the total estimated flood mitigation value. This suggests that current protection, which has been defined based on other criteria such as wetland extent and species richness, does not necessarily overlap with the wetlands contributing most to flood mitigation services. This pattern is likely explained by the concentration of protected wetlands in lowland coastal areas of high ecological importance and large spatial extent, while wetlands with higher flood mitigation value for downstream beneficiaries are more concentrated in upstream portions of the basin and remain less represented within the existing protection network. Similarly, in the Río Uruguay basin, 25% of the wetland area is protected, but this represents only 11% of the total estimated flood mitigation value. This protected value is entirely explained by wetlands included under SNAP.

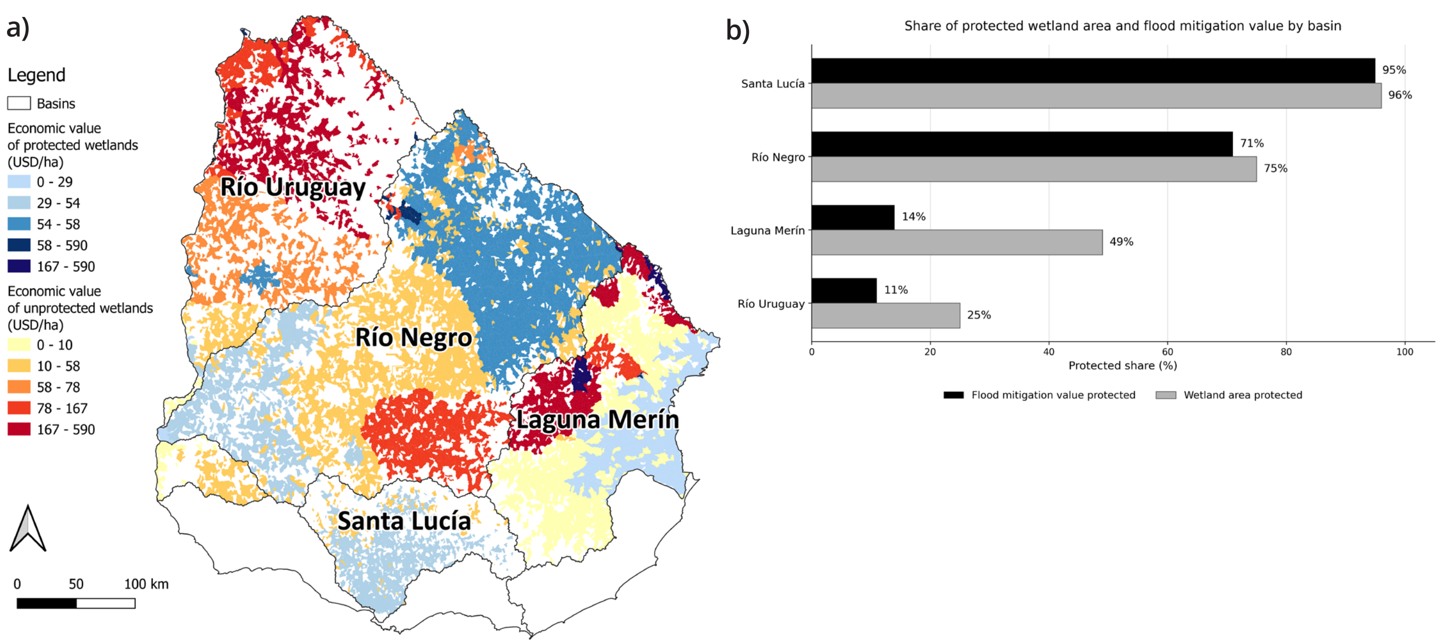


Figure 6a). Spatial distribution of wetland economic value for flood reduction (USD/ha) across protected (blue) and unprotected (red) wetlands, and **b)** Percentage of wetland area and associated economic value currently protected within each basin.

Figure 7a and b presents the results for the Río Santa Lucía basin, providing a closer-scale example of the national analysis. This basin-level view helps illustrate the spatial heterogeneity of wetland values and how the value of flood mitigation services depends on the relationship between wetlands and the location of downstream beneficiaries. It also allows for a clearer identification of implementation gaps, by showing where high-value wetlands are already protected, and where they remain outside the current protection framework. For example, areas upstream of San Ramón and Florida include both protected and unprotected high-value wetlands that play an important role in providing flood mitigation benefits to downstream communities. The high value of these wetlands is explained not only by their ecological characteristics, but also by their strategic location in relation to multiple downstream beneficiaries.

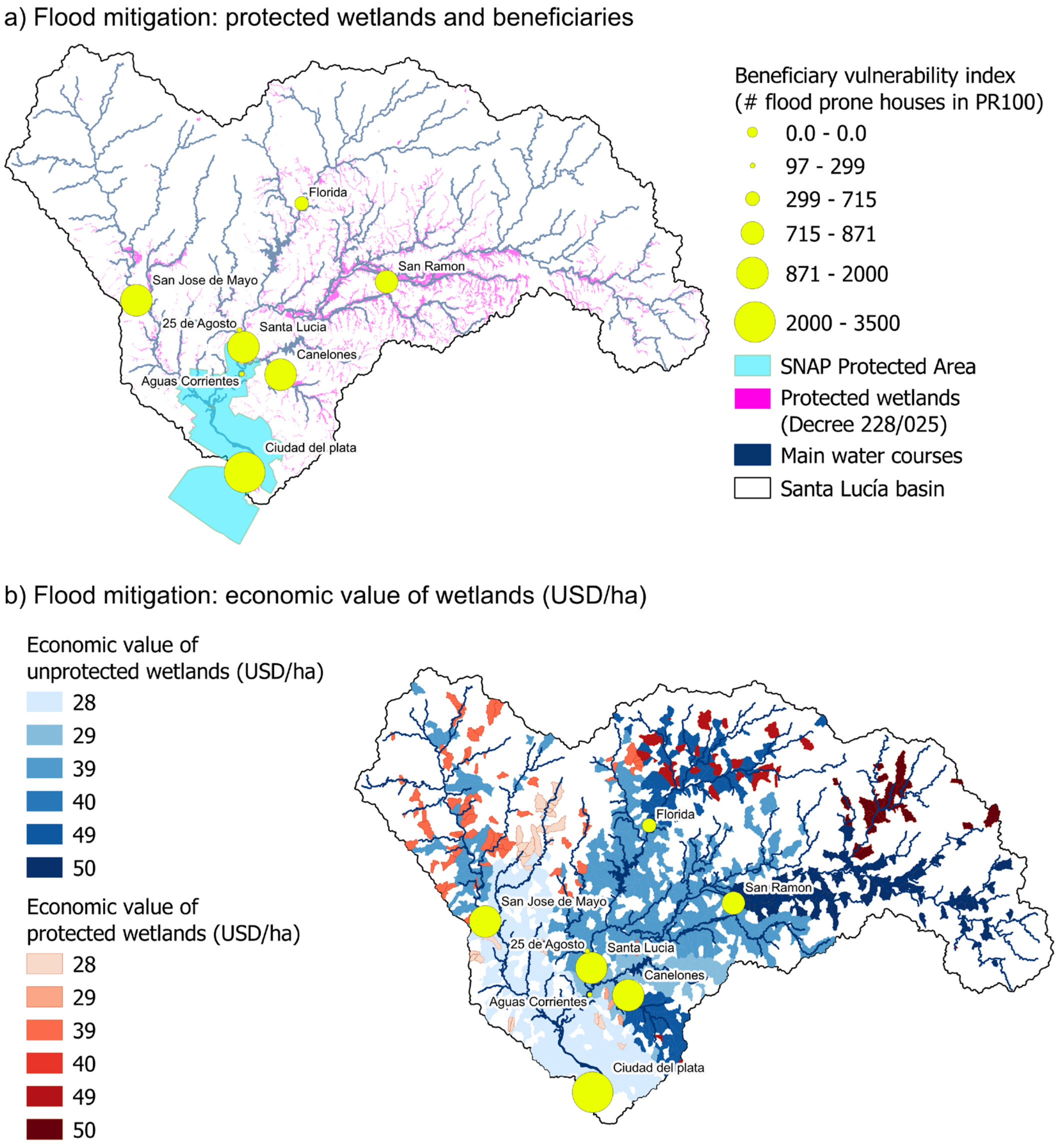


Figure 7a). Spatial distribution of beneficiaries, wetland protection status, and **b)** flood mitigation service values in the Río Santa Lucía Basin (protected wetlands are in blue scale, unprotected in red scale).

These results should be interpreted specifically in the context of the flood mitigation ecosystem service. The analysis evaluates the extent to which current wetland protection overlaps with wetlands contributing to flood risk reduction, and therefore the conclusions are valid when considering flood mitigation as the primary management objective. A broader assessment of the effectiveness of current protection frameworks would therefore require repeating this analysis across the full range of ecosystem services provided by wetlands. Integrating multiple ecosystem services would provide a more comprehensive understanding of protection priorities, potential tradeoffs, and synergies among conservation objectives across basins.

Coastal protection services provided by wetlands

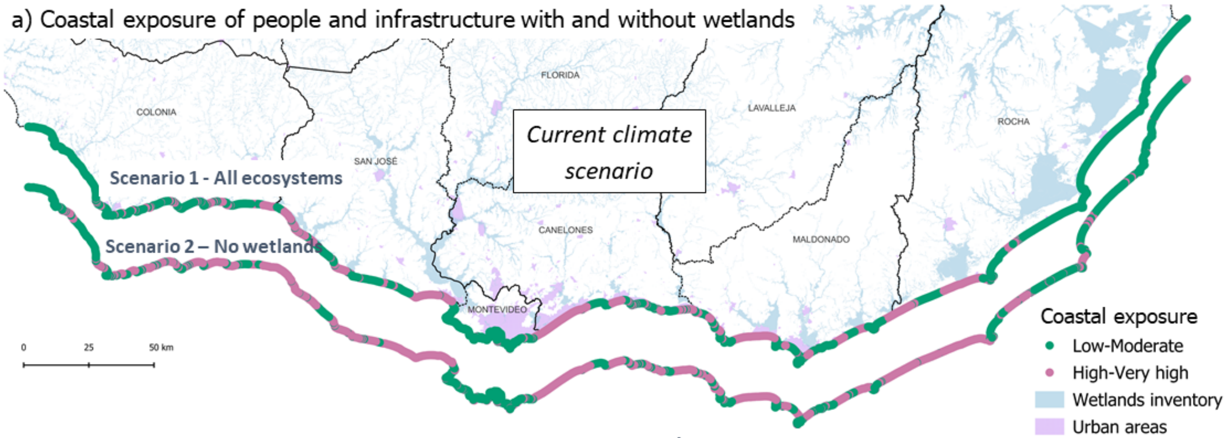
Lastly, the analysis evaluated the coastal protection services provided by wetlands to people and property along the coast under current conditions and future sea level rise. Key findings are shared below, with additional results provided in **Appendix A**. Coastal wetlands attenuate the impacts of tidal flooding, erosion, and storm surge through different physical and ecological mechanisms.[42] First, they retain and store large volumes of water, reducing the severity of flooding in adjacent coastal and urban areas during storm events. Second, coastal wetlands dissipate waves, reducing the height and velocity of waves that reach the shoreline. Finally, wetlands help to stabilize sediments and reduce erosion, contributing to the stabilization and protection of dunes and shorelines.

Coastal wetlands, under current sea levels, provide significant protection for an estimated 23% (158 km) of the Uruguay coastline, including 25,313 people and property valued at over USD 6.1 billion (representing ~6% of the total population and 11% of total property value of the coastal zone) (Figure 8a). This was defined by quantifying shoreline, people, and property that would be at the highest risk of exposure to coastal hazards without the protection provided by coastal wetlands (highest risk was the top 50% of the hazard index distribution in this study). In other words if coastal wetlands are lost, the total population living along coastline that is at the highest risk of exposure to coastal hazards increased from 60,922 to 86,235 people, while the value of property located along what is now considered high risk shoreline increases from USD 10.6 billion to over USD 16.7 billion. The 'avoided risk' to people and property across scenarios is the coastal protection service.

Coastal protection provided by wetlands becomes even more significant when rising sea levels due to climate change are considered (Figure 8b). Considering a future sea level rise scenario (see Appendix A for detailed information on development of a sea level rise scenario), the importance of coastal wetlands in providing coastal protection increases, reducing the number of people living along the highest risk shoreline by an estimated 57,237. Similarly, coastal infrastructure protected by wetlands under a future sea level rise scenario has an estimated value of USD 6.3 billion. It should be noted that the economic valuation for the coastal protection service does not represent an estimate of damages or an annual flow, unlike for the other services, but rather an indicator of priority.

42 The term "coastal wetlands" refers to the Ramsar classification "Marine/coastal wetlands".

a) Coastal exposure of people and infrastructure with and without wetlands



	Exposure	Habitat scenarios: All ecosystems	Habitat scenarios: No wetlands
Coastline (Km)	Low - Moderate	493	335
	High - Very high	182	340
Population (thousands)	Low - Moderate	338	313
	High - Very high	61	86
Economic valuation (USD millions)	Low - Moderate	43,095	36,970
	High - Very high	10,588	16,713

Coastal protection provided by wetlands:

- 158 Km of coastline protected
- 25k people protected by wetlands
- USD 6,125M in protected infrastructure

b) Coastal exposure of people and infrastructure under current and climate change scenarios

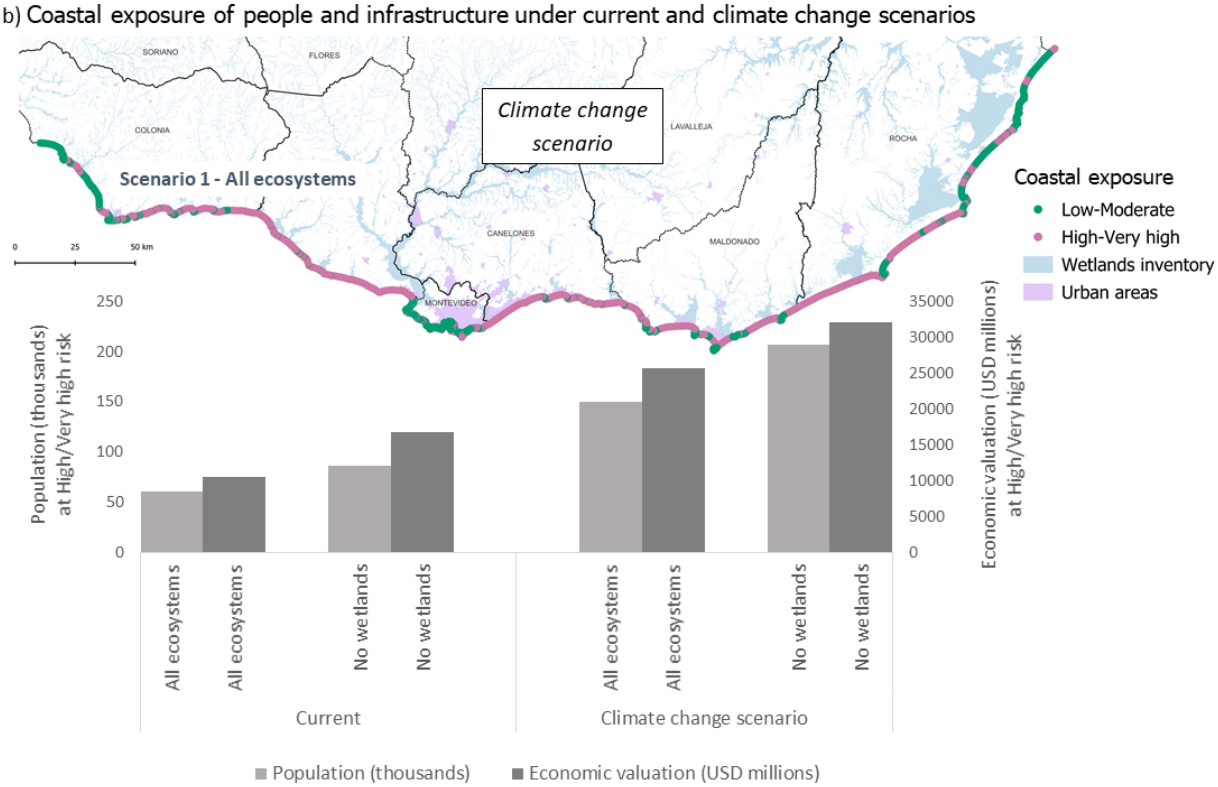


Figure 8. Valuation of the coastal protection service provided by wetlands in terms of length of coastline, population, and economic value of property protected under **a)** current conditions and **b)** a future sea level rise scenario. Coastal vulnerability increases in the absence of wetlands, and this negative impact exacerbates under a climate change scenario, highlighting the protective role wetlands provide.

Wetland protected status, urban expansion risk, and coastal protection services

Coastal protection provided by wetlands that are at high risk of degradation or loss due to urban expansion was also assessed in the analysis. Results from this can help identify areas where coastal wetlands are providing valuable protection to people and property, but also may be vulnerable to loss given their proximity to urban areas. The results show that the potential loss of wetland systems associated with urban expansion could increase levels of exposure to coastal hazards along approximately 388 km of coastline (57%), putting an estimated 138,409 people at increased risk (35% of the coastal population). Approximately half of this area (~ 168 km of coastline) could see significant increases in risk (defined as the top 25% of the distribution of coastal exposure index). Currently, only 11% (42 km) of the wetland area at risk of conversion to urban development is effectively protected under Decree No. 228/025, encompassing areas inhabited by an estimated population of 1,320 people. For example, Figure 9 shows that wetlands located in areas such as Aguas Dulces are providing critical coastal protection for the shoreline, but are effectively incorporated and protected under Decree No. 228/025. In contrast, wetlands located in areas such as Boca del Rosario, in Colonia, are providing critical coastal protection and are not protected under the Decree – putting them at high risk of conversion to development. Results from this analysis show that the potential loss of those wetland systems due to urban expansion could result in significantly increased levels of exposure to coastal hazards for people and property in the area.

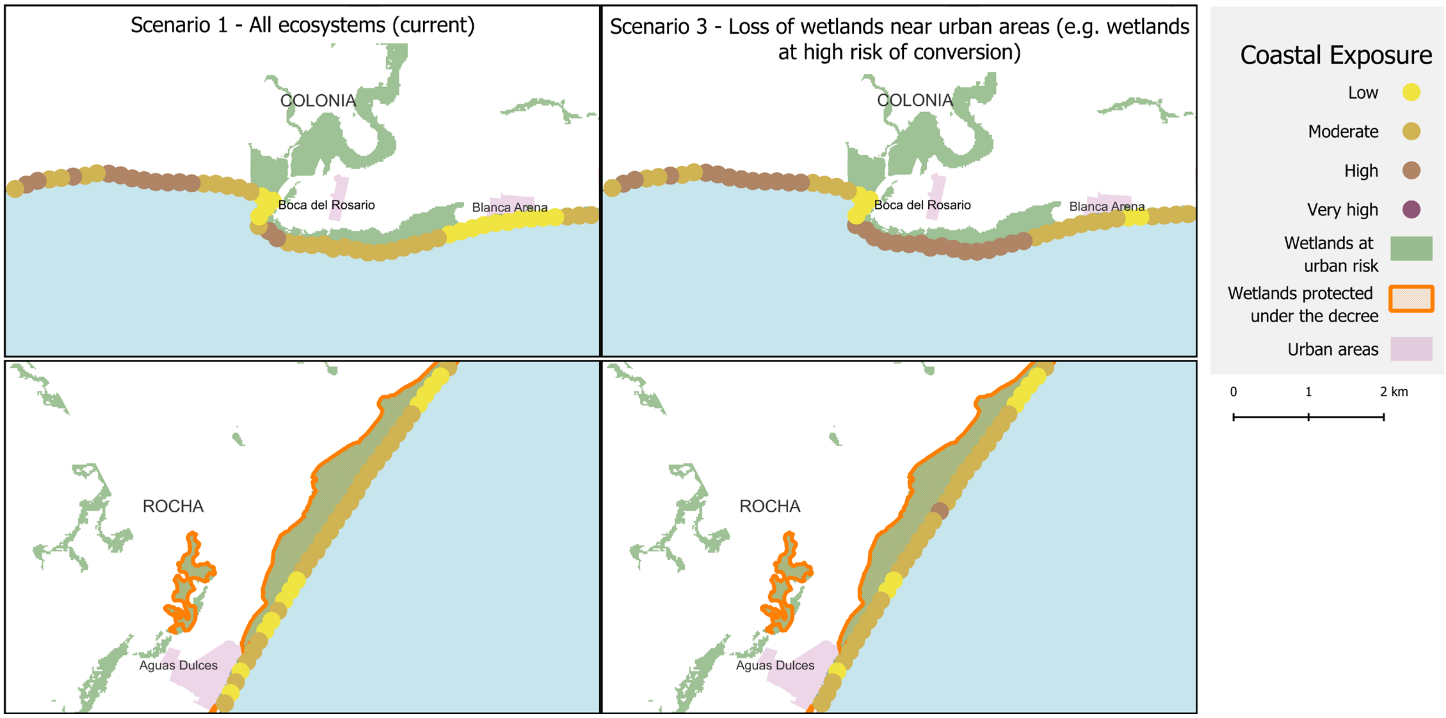


Figure 9. Coastal protection provided by wetlands near urban areas, and potential increases in coastal exposure if those wetlands are lost to urban expansion. Wetlands near Aguas Dulces are protected by the Decree No. 228/025, while wetlands in front of Boca del Rosario are not.

Integration with Policy and Finance

The results of this natural capital assessment provide a practical evidence base for integrating ecosystem service values into policy design, territorial planning, and investment decisions. By identifying wetlands that generate high-value benefits to society, the analysis can support both the implementation and monitoring of the current regulatory framework, particularly Decree No. 228/025. At the same time, this spatially explicit information can inform the development of complementary instruments aimed at strengthening implementation and expanding the provision of ecosystem services, both in regulated wetlands and in those currently outside the scope of regulation.

Regarding monitoring and implementation, the spatial identification of high-value wetlands can support the operationalization of Decree No. 228/025 by providing an objective basis to differentiate management priorities across sites. This information can inform the definition of use restrictions, restoration needs, and monitoring requirements according to the ecological and socioeconomic importance of each wetland. In this context, monitoring efforts can be more strategically targeted toward areas where changes in ecosystem condition would have the greatest environmental and socioeconomic impacts. It also facilitates coordination with territorial planning and coastal zone management processes, enabling more targeted and context-specific implementation of existing and new policy instruments.

Regarding the development of complementary instruments, the analysis explored the potential use of fiscal incentives for wetland conservation, drawing on lessons from Uruguay's native forest policy. It also advanced the identification of KPIs to facilitate the integration of wetlands into environmental and sustainability-linked financial instruments. The information generated through this natural capital assessment also lays the groundwork for the exploration and development of other instruments such as water funds, payments for ecosystem services (PES), green and blue bonds, habitat banks, creation of natural capital accounts, or the issuance of biodiversity or carbon credits. Additionally, this pilot provides input for future projects that could continue the lines of work initiated, such as the project, "**Strengthening Wetland Conservation Policy in Uruguay: Integrated Management with Sustainable Funding**," financed by the Global Environment Facility and implemented by the IDB, or the Biodiversity Finance Initiative (BIOFIN) being implemented in Uruguay.

Exploratory assessment of a fiscal incentive for wetland conservation

A fiscal incentive for wetlands has the potential to complement regulatory instruments, improve the targeting of conservation efforts, and support the development of a more integrated policy mix. Its effectiveness will depend on the balance between simplicity, fiscal cost, and the ability to generate additional conservation outcomes.

Uruguay's native forest policy provides a relevant reference for the design of such instruments. Under the current framework, landowners who register native forest areas with the Forestry Directorate of the Ministry of Livestock, Agriculture and Fisheries may access tax exemptions, creating an incentive linked to the formal recognition of these ecosystems. Estimates suggest that, in 2025 values, the average (potential) tax benefit is approximately USD 26/ha,[43] although the actual amount varies depending on the type of producer, tax regime, and the formal registration status of the forest.

Evidence from previous analyses indicates that the impact of this incentive depends on the initial

43 MGAP y MVOTMA. (2019). **Análisis tributario asociado al bosque nativo**. Proyecto REDD+ Uruguay. Fondo Cooperativo para el Carbono de los Bosques (FCPF). (Note: Updated value using Readjustable Unit and average exchange rate for 2016 and 2025)

conditions of landowners.[44] For non-registered forests, the fiscal benefit primarily acts as an incentive for registration and, in some cases, for compliance with management regulations. It may also discourage illegal land-use change by partially offsetting the economic gains from non-compliance. For registered forests, the incentive operates mainly as a reward for conservation or sustainable management, and as an incentive to remain in compliance.

There are important differences between native forest and wetland ecosystems in terms of their interaction with compatible productive uses, particularly livestock production. Broadly, the main distinction lies in the ecosystem services they provide: native forests primarily offer shade and shelter for cattle while their forage provision is generally limited (depending on forest type), whereas wetlands mainly provide forage when not flooded and can serve as a reserve during dry summer periods.[45,46] As a result, the benefits derived from these ecosystems for livestock production differ. Although this depends on factors such as ecosystem type, livestock access, and farm conditions, wetlands generally provide greater forage availability than forests, making them more directly valuable for cattle production. This also implies that the opportunity costs associated with conserving wetlands may be lower than those associated with conserving native forests, since wetlands can remain compatible with productive activities under certain management conditions. Consequently, a tax exemption scheme for wetlands may generate conservation incentives while involving relatively lower economic tradeoffs for producers. However, despite these benefits, landowners may still face opportunity costs to maintain wetlands when alternative, more intensive land uses—such as conversion to agricultural production—are considered.

Building on these insights, the introduction of a rural land tax exemption for wetlands is explored as a complementary mechanism to the existing policy framework. Three main policy benefits of such an exemption were identified:

- **Compensation for opportunity costs**
  Wetlands conservation may constrain productive land use due to flooding or restrictions on conversion. A tax exemption can partially offset these costs. Preliminary estimates suggest that the agricultural opportunity costs associated with preventing wetland conversion to rice production system may be on the order of USD 115/ha, providing a reference point for assessing the adequacy of the incentive (see Appendix A). This comparison indicates that, depending on its design, the tax exemption may only partially compensate for these costs.
- **Recognition of ecosystem service provision**
  The instrument can recognize landowners who steward wetlands that contribute to the provision of public benefits, including water regulation, carbon storage, coastal protection, and flood mitigation.
- **Support for wetland delineation and registration**
  Similar to the native forest regime, the incentive can encourage landowners to delineate and register wetlands, contributing to improved spatial data and supporting policy implementation.

It is important to note that fiscal incentives imply a foregone public revenue, and their total cost will depend on the scope of application and level of uptake. This highlights the need for careful targeting to maximize environmental benefits per unit of fiscal expenditure. It is also crucial to have a robust system for monitoring compliance with tax obligations, as well as the resources to implement it. This is key to ensuring the tax's effectiveness and avoiding distortions that yield no results in terms of wetland protection.

Different potential targeting strategies were identified, each with implications for effectiveness and cost:

- **Universal coverage (all wetlands are applicable)**
  This approach mirrors the application of the native forest tax exemption. It maximizes simplicity and coverage but may result in high fiscal costs and limited additionality.

44 MGAP y MVOTMA. (2019). Op. Cit.

45 INIA. (2022). Serie técnica 261 (pp. 80–92).

46 PPD Uruguay. (s.f.). Manejo y utilización de bañados/humedales en sistemas de producción ganadera del norte de Rocha.

- **Wetlands currently protected under the Decree No. 228/025**
  Reinforces the current framework but may have limited incremental impact.
- **High ecosystem service value wetlands (regardless of their protected status)**
  Improves cost-effectiveness by prioritizing areas with the highest public benefits, based on natural capital results.
- **High-value wetlands outside decree protection**
  Addresses policy gaps and expands protection, but may raise equity concerns if regulated areas are excluded.

Beyond compensation, the incentive can also function as a tool to strengthen monitoring and management. In this sense, eligibility could be linked to some or all of the following: wetland registration and characterization, basic management or conservation plans, and/or participation in monitoring or reporting systems

This would allow the instrument to generate both conservation outcomes and improved data, supporting future policy and financial instruments.

Additional design considerations emerging from the native forest experience include:

- Differentiating the level of fiscal benefit according to the magnitude and value of the ecosystem service provision or ecological condition of wetlands, thereby better aligning incentives with the magnitude of public benefits generated.
- Requiring periodic updates of the registry to enable monitoring and adjustment of benefits over time.
- Incorporating standardized information in the registration process to assess ecosystem condition and support targeting.

Finally, it is critical to ensure that the transaction and compliance costs associated with registration and monitoring remain lower than the expected fiscal benefit for landowners. Otherwise, participation rates may be limited, reducing the effectiveness of the instrument.[47]

As one of the lines of work that could further develop these findings, a future assessment could explore, through the projects mentioned above, the potential of instruments such as biodiversity or carbon credits as a source of income for landowners. Likewise, the development of these markets can provide the methodological and institutional foundation for the development of more complex instruments such as habitat banks.

Proposal of Key Performance Indicators (KPIs) for Wetland-Related Financial Instruments

As noted above, the Government of Uruguay has already issued sustainability-linked instruments, including a sovereign sustainability-linked bond and a World Bank loan indexed to environmental performance. To date, the indicators used in these instruments have focused on native forest area and Nationally Determined Contribution (NDC) targets. Building on this experience, this analysis identifies and evaluates a set of potential KPIs to support the design of financial instruments linked to wetland conservation and restoration.

Drawing on international experience in sustainability-linked finance, KPIs were structured across four dimensions: ecological, hydrological, climate, and socioeconomic. An initial long list of indicators was compiled based on the literature and existing frameworks (see Appendix A). These indicators were then assessed using four key criteria commonly applied in sustainable finance: measurability, verifiability, policy relevance, and simplicity. Each KPI was qualitatively scored to support a preliminary

47 MGAP and MVOTMA. (2019). *Op. Cit.*

prioritization. This exercise should be considered a first step and would benefit from further validation with national stakeholders.

This prioritization is aligned with the IDB and EIB guide, "Financing Nature: A Practitioner's Guide to Results Metrics Selection,"[48] which recommends selecting nature-finance metrics through an explicit impact pathway linking financed activities to expected outcomes. The guide disntinguishes between response metrics (which assess the scale of activities implemented), pressure metrics (which assess how far the actions reduce pressures on nature and where feasible), and state metrics (which assess beneficial outcomes for the state of nature). This is a useful framework for wetland-related instruments because it helps balance easily verifiable indicators, such as hectares conserved or restored, with more outcome-oriented indicators, such as wetland condition, hydrological connectivity, or water quality.

The analysis shows that while a wide range of indicators can capture wetland benefits, not all are equally suitable for financial instruments. Indicators that serve financial instruments best are those that can be clearly defined, measured, verified, and monitored at reasonable cost over the life of the instrument. They should also be easy to interpret by issuers, investors, auditors, and public authorities, and sufficiently attributable to the conservation or restoration intervention.[49] Area-based indicators (conserved and restored wetlands) perform best across evaluation criteria due to their high measurability, low monitoring costs, and strong alignment with existing policy frameworks. For this reason, they are most suitable as primary KPIs or eligibility metrics for financial instruments. More advanced indicators, such as ecological integrity and hydrological connectivity, provide important complementary information on ecosystem functionality but involve higher complexity in measurement and verification. These are therefore better suited as supporting indicators, safeguards, or longer-term outcome metrics, rather than as primary financial KPIs.

In this sense, conserved and restored areas can be understood mainly as response metrics, while ecological integrity functions as a state metric. Combining both types of indicators strengthens the credibility of the KPI framework, as it captures both implementation progress and changes in wetland conditions.

Based on this assessment, a tiered KPI approach may be best to balance practicality and ecological relevance. Core indicators would focus on conserved and restored wetland area, while complementary indicators would capture ecosystem condition. Where data availability allows, future iterations could also incorporate pressure indicators, such as reductions in drainage, nutrient loads, invasive species, or hydrological alteration, moving toward a more complete response–pressure–state monitoring framework.

Core indicators

- Conserved wetland area (ha)
- Restored wetland area (ha)

Core indicators should be reported annually using administrative and geospatial data from the wetland registry. Conserved area refers to wetlands maintained under protection without conversion, while restored area captures active interventions aimed at recovering wetland functions. Together, they provide a consistent baseline for tracking policy uptake, coverage, and progress toward targets.

Complementary indicator

- Ecological integrity index

An ecological integrity index can be used to assess wetland condition based on a limited set of variables (e.g. vegetation cover, hydrology, and degradation signals), building on established approaches.[50] A

48 Inter-American Development Bank & European Investment Bank. (2025). **Financing nature: A practitioner's guide to results metrics selection.**

49 ICMA. 2024. Sustainability-Linked Bond Principles: Voluntary Process Guidelines. International Capital Market Association.

50 United States Environmental Protection Agency (2016). *National Wetland Condition Assessment 2011: A Collaborative Survey of the Nation's Wetlands.* EPA 843-R-15-005. Washington, DC.

practical implementation can rely on remote sensing; for example, the Alpine Wetland Degradation Index (AWDI) combines satellite data on vegetation condition, surface water dynamics, and land-use pressure to produce a degradation score, enabling classification and monitoring over time.[51] This indicator can be updated periodically (e.g. every 2–3 years) and used to support both monitoring and targeting of incentives.

Other applications of the results for policy and instrument design

Beyond the design of fiscal incentives and financial instruments, the results of the natural capital assessment can inform a broader set of policy and management tools. Natural capital approaches can support regulatory instruments such as land-use planning and environmental impact assessments; economic instruments such as PES, subsidies, or environmental taxes; financial mechanisms including environmental funds, green bonds, and results-based finance; as well as enabling and voluntary approaches such as natural capital accounts, ESG frameworks, and certification schemes.

The spatial prioritization of high-value wetlands and the development of KPIs provide cross-cutting information that can support conservation targeting, investment prioritization, monitoring efforts, and the integration of ecosystem service values into public and private decision-making. However, it is important to recognize that the economic valuation of ecosystem services is a methodological tool with inherent limitations, and that results are strongly conditioned by data availability, methodological assumptions, and available resources. Therefore, transitioning from valuation to a tangible instrument is not automatic; rather, valuation should be understood primarily as an input into broader decision-making processes. Institutional, political, legal, and cultural contexts ultimately shape the feasibility and effectiveness of specific instruments. Furthermore, implementing economic or financial instruments should not obscure the fact that this valuation exercise represents only a partial approximation of the total value of wetlands, leaving out many ecosystem services, cultural dimensions, and non-use values that may also be socially and ecologically important.

Finally, economic and financial instruments ultimately seek to generate behavioral changes among stakeholders, which also requires addressing broader structural and country-specific challenges. The development of specific instruments may therefore require additional valuation of other ecosystem services, updates to the current assessment, or the expansion of the analysis to broader geographic areas. These aspects could be explored in greater depth in subsequent projects.

Implications across instrument types

Regulatory instruments: Support the refinement and implementation of existing regulations (e.g. wetland protection, zoning), enabling differentiated management and monitoring based on ecosystem service value.

Economic instruments: Inform the design of PES and other incentives (e.g. subsidies, compensation mechanisms), improving targeting and linking payments to ecosystem service provision.

Financial instruments: Provide a basis for integrating wetlands into results-based finance, green bonds, and sustainability-linked instruments through the definition of robust KPIs.

Enabling and voluntary instruments: Strengthen natural capital accounting, planning processes, and stakeholder engagement, supporting coordination and evidence-based decision-making in environmentally dependent sectors.

51 Zhao, X., et al. (2023). *An alpine wetland degradation index (AWDI) based on remote sensing for monitoring wetland condition*. Journal of Environmental Management, 335, 117543.

Capacity Development

Capacity development was a primary focus of this pilot project, with the goal to build capacity among several different audiences. Table 4 describes the different groups that participated in the project, and the main capacity development activities for each. Briefly, these groups included:

A **core technical team** which was assembled early in the pilot, with the goal to build a small group of staff from key government ministries, local consultants, and regional and local IDB offices who would receive in-depth technical training for the duration of the pilot, and could then train and advise others following a 'train the trainers' model. The core technical team was largely responsible for conducting all parts of the ecosystem service assessment and valuation for the pilot, including collecting and processing input data, parameterizing models, developing and running scenarios, conducting economic valuation, and developing final figures and deliverables. The IDB provided key guidance throughout the pilot to link technical analysis to policy and finance outcomes. The core technical team met weekly and then bi-weekly over Zoom for the course of the pilot. The team also traveled to Stanford University for a week-long intensive working group session.

Core technical team during working session at Stanford University in November 2025. Image credit: Guillermo Sena.

High-level decision-makers in key ministries were a second audience for capacity development activities. The capacity development-focused goal for this group was to provide them with regular opportunities to learn about and engage with natural capital information during the pilot project. A diverse group of ministries participated in the pilot, to promote learning and collaboration among ministries that may typically be under-represented in natural capital conversations. This includes representation from the Ministry of Economy and Finance, Ministry of Land Planning, and Ministry of Livestock, Agriculture and Fisheries. Incorporating diverse ministries over the course of the assessment sought to support multiple outcomes: (1) to introduce critical and often under-represented perspectives into conversations about how to use natural capital information to inform policy and finance instruments, ultimately making assessments more useful and tightly connected to policy and finance demands, (2) socializing the outputs and value of natural capital information among decision-makers who might be less familiar with these types of approaches, and (3) cultivating a broad base of support and buy-in for the assessment and its end results. This group was convened by way of (1) a coordination group that met bi-weekly throughout the duration of the pilot to provide guidance, and (2) an advisory council composed of high-level directors from six key government ministries that met three times over the course of the project. All of these meetings were held over Zoom.

Lastly, to develop a broader community of practice in Uruguay, the pilot included additional training (over Zoom and in-person), webinars, and materials throughout the duration of the project for a larger group of government officials, academics, NGOs, and consultants (see Table 4). Additional materials include a comprehensive syllabus linking to videos and slides from every technical team meeting, a full technical appendix with replicable workflows for the analysis, and archived model inputs and outputs that will be made publicly available. This ensures there is a wealth of publicly available materials building on the information produced locally and lessons learned in the pilot, to support the design and implementation of future natural capital assessments by other consultants, government staff, and academics in Uruguay.

Table 4. Summary of key capacity development activities among different groups engaged.

Capacity Development Groups	Key activities
Core technical team • Biodiversity and Ecosystem Services Directorate (DINABISE) & Climate Change Directorate (DINACC) – Ministry of Environment (MA) • Ministry of Economy and Finance (MEF) • External consultants (economic valuation, GIS/spatial analysis) • Stanford Natural Capital Alliance team (Hydrologist, GIS Analyst, Engagement Lead, Student Intern) • IDB (country and regional teams)	• **Technical training and engagement sessions (June 2025 – July 2026):** A series of tailored sessions were delivered to the core technical team and staff from six government agencies. These sessions combined hands-on training in the application of InVEST models with technical discussions on their adaptation and implementation in the Uruguayan context. The initial 11 sessions focused on introducing the InVEST model suite and working through model data needs and workflows, described in detail in **Appendix B: InVEST Training Syllabus for Uruguay Team**, which provides a syllabus and detailed agenda for each session. Subsequent sessions over 7 months focused on mentoring the team through technical aspects of the analysis and the application of the results in Uruguay. • **International working group session (November 2025):** The core technical team participated in a one-week intensive working meeting at Stanford, focused on advancing the analysis and developing key deliverables. • **Coordination Group engagement (June 2025-July 2026):** A coordination group met biweekly to provide ongoing guidance and feedback on pilot implementation, while also strengthening familiarity with ecosystem services assessments as a decision-making tool.
Advisory Council **Directors from key government directorates:** • DINABISE and DINACC (MA) • Economic Policy Directorate (MEF) • Land Planning Directorate (DINOT)- Ministry of Land Planning (MVOT). • Office of Agricultural Programming and Policy (OPYPA) & Natural Resources Directorate (DGRN) - Ministry of Livestock, Agriculture and Fisheries (MGAP). • Core Technical Team members	• **Advisory Council engagement (October 2025 – March 2026):** An advisory council composed of senior government officials (director level, representing six agencies) met three times during the project to provide strategic guidance and ensure alignment with policy priorities.
Broader Community of Practice • 30+ representatives from academia, ministries, and consultants	• **Webinars (October–December 2024):** Three webinars were delivered to a general audience, introducing the basic concepts of ecosystem services and natural capital approaches. These sessions also included participatory workshops to gather input on wetlands in Uruguay. • **InVEST training workshop (February 2025):** A two-day, in-person training was held in Montevideo for 32 participants, including government staff from seven agencies, academics, Inter-American Development Bank staff, NGOs, consulting firms, and independent consultants. • Final Presentation at Uruguay Environmental Exposition 2026 (June 2026): A public presentation and panel discussion focusing on results and application of the pilot. • **(Materials available at the end of the pilot):** A course syllabus developed during the pilot building on the technical team trainings including recordings and slides, a technical appendix of the analysis including replicable workflows, and InVEST model data inputs and outputs archived and available for public use on the Natural Capital Alliance Data Hub.

Key Outcomes

The following key outcomes have been accomplished through the Uruguay pilot:

1

Policy and finance outcomes

- This analysis was designed with multiple policy endpoints in mind, and produced ecosystem services assessment and valuation results that can be used to inform multiple policy processes. This includes the initial policy opportunity to support the implementation of Decree No. 228/025, but also potential secondary opportunities to support the Río Santa Lucía River Basin Action Plan, the National Biodiversity Strategy (by informing the voluntary targets to achieve land degradation neutrality), as well as informing the development of wetland-related NDCs. This outcome reinforces the value of natural capital information as a resource that can be utilized in many different processes simultaneously.
- The project explored potential policy instruments and financial mechanisms based on existing frameworks in Uruguay. It also identified specific ways in which the information generated by the assessment could be used to structure incentive systems, prioritize areas, and define key performance indicators. The results obtained provide a basis for further work on the design of financial and policy instruments that support wetland conservation.
- Uruguay, with support from the GEF under the Kunming-Montreal Global Funding Framework (GBFF) and the IDB, has begun structuring the project, "Strengthening Wetland Conservation Policy in Uruguay: Integrated Management with Sustainable Funding." The capacities developed in this pilot project and the results of the economic valuation will serve as a foundation for this continued work on wetland conservation. The new project could continue some lines of work that were outlined or initiated in this pilot project, as it includes a focus on biodiversity and ecosystem services, and implementing financial mechanisms for wetland conservation.

2

Capacity development outcomes

- Significant capacity has been developed among key ministerial staff and consultants in Uruguay to conduct full ecosystem services assessments and valuation, and among high-level decision-makers to understand the use of natural capital information in informing policy and finance instruments. Moving forward there is skilled technical capacity in Uruguay that can implement natural capital approaches from start to finish to inform future policy and finance opportunities.
- International recognition of two members of the Uruguay technical team, as two recipients of the 2025 and 2026 Natural Capital Young Leaders Prize, helped catalyze additional interest in the pilot beyond the focal ministries -- culminating in a closure event for the pilot with a presentation in the Office of the President in September 2026.

3

Technical outcomes

- The technical team produced a highly advanced ecosystem service assessment of wetlands in Uruguay. This included running four ecosystem service models at multiple spatial scales, with multiple scenarios of wetland loss and degradation, as well as a climate change scenario for the coastal hazard modeling. For each of the four services, beneficiaries were identified and a valuation approach was developed and implemented. The scope of this assessment represents a technical lift beyond what is often produced in a rapid natural capital assessment, and by a team that was also learning new materials and tools at every step of the way.
- A second technical outcome of the pilot was the development of a novel hydrologic routing system to capture wetland processes in more detail. The development of this additional modeling framework enabled the Uruguay assessment to produce detailed, fine-scaled results reflecting wetland processes, but it is also a workflow that could ultimately be implemented in the InVEST suite, to be made available to others around the world working in similar systems.

Lessons Learned

Capacity development lessons learned

The Uruguay pilot built a cohesive and productive local technical team. Executing technical capacity development in a virtual context depends in large part on architecting a well-built team, and thus explicitly highlighting lessons learned from this success can help to inform future similar teams.

Co-project management between the local team and the Stanford Natural Capital Alliance team was a highly effective strategy to keep both teams tightly coordinated and on-time. In this pilot, local project management was explicitly a compensated position fulfilled by a consultant in Uruguay. Typically there will be a local lead, but often they are a government representative providing vision and guidance over the analysis, but with little capacity to do day-to-day project management activities. In this pilot, the co-management on the Stanford side and the local side was an effective mechanism to ensure the project stayed well-organized, productive, and delivered on-time.

The core technical team had **representation from a diverse group of ministries and technical specialities.** For example, the team included a member of the Ministry of Economy and Finance, who participated in all technical sessions and provided ongoing, valuable guidance for applying results of the pilot to financial and policy instruments. Often natural capital assessments are siloed within environment ministries, or planning staff and may only intermittently receive feedback from finance ministries. Having the representative of the Ministry of Economy and Finance embedded with the team through the entire pilot ensured that the results were being developed with an eye towards informing relevant policy and finance instruments. Reciprocally, this also builds capacity in finance to understand how to leverage information from assessments in their processes, ultimately in service of mainstreaming these approaches.

The structure of the Uruguay pilot included investing many hours of technical training into a small team. The extent to which this will develop into an effective ‘train the trainers’ model in Uruguay is unknown, as there are no explicit requirements that the core technical team facilitate training of others. **Thus, monitoring both the outcomes of the Uruguay pilot and also the broader uptake of natural capital approaches in Uruguay, should be considered in order to evaluate effectiveness and tradeoffs associated with this in-depth ‘core team’ technical training approach.**

Technical lessons learned

The **lack of a nationally consistent wetland map** made the analysis challenging. Wetlands are a challenging ecosystem to map because they can be ephemeral, and Uruguay has several different national maps of wetlands produced by different government agencies, all of which differ in extent from each other. This required the pilot team, in coordination with technical staff from government agencies, to make decisions in order to select a single map for the analysis. The lack of a nationally accepted LULC layer could lead to complications among decision-makers if the wetland map used in the analysis isn't the same one used by a given agency.

This pilot provided a good example of **demand-driven tool development,** in this case, the development of an additional hydrologic modeling component to specifically address wetland processes. NatCap should explore the potential for incorporating this into InVEST to make it available for other users.

While considering how to map and quantify carbon storage, it became clear that there is very little published data regarding carbon storage and sequestration in Uruguay – neither spatial maps nor land cover-based measurements. Quantifying the biomass and soil carbon contained in different vegetation types, soil types, and especially wetlands nationally is a significant area of future research that would **increase the accuracy and certainty of carbon mapping and valuation.**

Read more on the pilot project page:
bit.ly/3PsUruguay.

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