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# Contributions of Natural Capital Approaches to the Implementation of Public Policies in Chile

## Final Report

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Integrating Nature into Policy and  
Investment Decisions

Final Report

# Contributions of Natural Capital Approaches to the Implementation of Public Policies in Chile

**Chile**



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# Executive Summary

The natural capital valuation pilot project in the Río Bueno basin represents an application of **natural capital approaches** (NCA) in Chile, demonstrating how ecological, economic, and regulatory evidence can be translated into concrete tools for the implementation of public policies at the regional level. The initiative measures the benefits nature brings to the economy and society using scientific methodologies, and connects this with public policymaking. This strengthens coherence between levels of government and between environmental and economic policies, improving results for both people and nature.

The pilot project was designed to address a key gap identified by Chile's Natural Capital Committee: the lack of actionable and integrated information about the biophysical, economic, and regulatory dimensions of natural capital, which would allow it to be incorporated operationally into public decisions at local and regional levels. The project was implemented with the purpose of quantifying, mapping, and valuing ecosystem services (ES) relevant to well-being- and economy-related issues, and integrating this information into public policy instruments, in particular the application of **Law No. 21,600**<sup>1</sup> that creates the **Biodiversity and Protected Areas Service** (SBAP) and its Biodiversity Offsets Instrument.<sup>2</sup>

The project applied natural capital approaches at a regional level in the Río Bueno basin, combining the biophysical modeling of ecosystem services using the InVEST<sup>3</sup> tool, the economic valuation of these services, and a regulatory and institutional analysis, to generate portfolios of preferred restoration areas that incorporate the co-benefits to people of various ES. First, the team generated a baseline value of the region's natural capital through maps of supply

and use of six priority ES, and monetary estimates expressed as **Total Economic Value** (TEV), which in turn were mapped to show spatially the economic value of the interaction between the areas where the ES are generated and the beneficiaries of those services. The results show that the natural capital of the basin currently generates annual benefits estimated at USD **496 million**, with notable contributions from climate regulation, sediment retention, and water regulation services. This natural capital assessment framework was in turn used to identify areas with optimal restoration opportunities, which maximize co-benefits related to supply of several ES.

In addition, a regulatory analysis of Law No. 21,600 and its biodiversity offsets instrument was prepared for the basin, using the criteria for selecting and prioritizing ecological restoration for biodiversity loss to generate an offsets priority map based on the regulation. This analysis of policy instruments identified key information requirements, gaps, and opportunities, which guided the development of the project's spatial outputs and highlighted concrete, actionable opportunities to integrate natural capital information into policy instruments.

Finally, ecological, economic, and regulatory criteria were integrated, generating a portfolio of preferred zones where **strategic ecosystem restoration actions generate co-benefits in various ecosystem services and lower opportunity costs, and which in turn are compatible with biodiversity policy priorities.**

The study demonstrates that NCAs are a **viable technical tool** to increase the efficiency of the Biodiversity Offsets Instrument, and in turn, provide inputs that facilitate management outlined in other SBAP instruments. Its application can improve the

1 **Law No. 21,600** – Creation of the Biodiversity and Protected Areas Service (SBAP) and the National System of Protected Areas, establishing principles such as the valuation of ecosystem services.

2 Biodiversity Offsets Instrument (Art. 38 Law No. 21,600)- Defines criteria to compensate for biodiversity loss by project developers, incorporating ecosystem functionality and measurable goals.

3 **InVEST** (Integrated Assessment of Ecosystem Services and *Trade-offs*), a free and open-source software suite developed by the Natural Capital Alliance at Stanford University.

traceability and transparency of offset measures for residual impacts of projects on biodiversity. This provides SBAP and project developers with data and technical processes for identifying and prioritizing potential areas for ecological restoration that offer the greatest social and economic co-benefits. In turn, it is also a basis for assessments of biodiversity restoration actions – which must be carried out at the scale of individual projects – to incorporate incremental effects. **The methodology developed is replicable and adaptable to other locations and contexts**, offering a basis to scale the approach at the national level and strengthen the integrated management of natural capital in Chile.

In addition to strengthening institutional coherence, the approach contributes to the country's economic productivity and competitiveness through increasing awareness about economic and social vulnerability stemming from the loss of ecosystem services and promoting management that reduces those risks in strategic sectors.

The report's main recommendations highlight the need **to translate technical results into concrete actions by the instrument's lead institutions, and to strengthen institutional coordination and technical capacities.**

Another key recommendation is the need to move towards data governance, with interoperable systems and effective communication. All of this will allow the adoption of NCA and the management of nature as a strategic asset in different areas.

#### Box 1

The valuation of natural capital and ecosystem services obtained in the project should not be interpreted as market prices or transactional values of nature, but as analytical references that reflect the associated economic and social susceptibility to the loss of these services due to environmental degradation. They provide an evidence base to guide management by identifying socioeconomic dependencies on ecosystems, recognizing strategic areas and focusing management instruments on areas where nature supports critical functions for well-being and productivity.



# Introduction

In Chile, the recognition of nature and biodiversity as strategic assets that underpin well-being, economic productivity, water security, and resilience to climate and environmental risks has achieved important institutional and regulatory advances in recent years. Recent milestones, including the formalization of the Natural Capital Committee of Chile (NCC)<sup>4</sup> in 2023 and the publication and enactment of Law No. 21,600 in the same year, are the result of institutional continuity promoted by different governments. These efforts have worked to consolidate coordination and integrated management of the environment, economic development, financing, and public investment. The NCC acts as an advisory body to the President of the Republic, proposing actions in matters related to the measurement, valuation, protection, restoration, and improvement of Chile's natural capital – in order to integrate nature and biodiversity into designing and implementing sustainable development.<sup>4</sup> This has strengthened the country's intersectoral governance and public policies focused on integrating the benefits of nature in decision-making.

Through Law No. 21,600, the Biodiversity and Protected Areas Service (SBAP) was created to enable instruments such as ecological planning, certification of biodiversity and ecosystem services, biodiversity offsets, and contracts for remuneration of ecosystem services, among others. In particular, the offsets instrument establishes mechanisms to compensate for the residual impacts of projects on biodiversity within the framework of the environmental impact assessment system, guiding the implementation of ecological restoration measures that ensure measurable and sustainable results over time. Together, these innovations operationalize the relationship between nature, economic activity, and human well-being, connecting the measurement and valuation of nature's benefits with concrete environmental management actions. In this context,

the NCC chose to develop a pilot for the application of natural capital approaches (NCA) in the Río Bueno basin, located in the Los Ríos and Los Lagos regions, to inform decision-making on public policies, investment plans, and financial instruments. The objective is to demonstrate, on a subnational scale, how NCA can act as a connector between national, regional, and sectoral frameworks, facilitating the coordination of public policies, local implementation, and monitoring progress toward development and sustainability goals. The pilot in the Río Bueno basin functions as a subnational demonstration, linking knowledge about natural capital with key policy instruments and strengthening decision-making and inter-institutional articulation. The Río Bueno basin was selected by the NCC from among various proposals from the committee for bringing together a relevant combination of ecological, productive, and institutional attributes at the subnational scale. The ecological diversity and natural capital components of the watershed (shown in Figure 1—soils, native forests, wetlands, grasslands, rivers) provide benefits to local communities, basic services, agriculture, industrial sectors, cities, and other actors.

<sup>4</sup> **Natural Capital Committee:** an inter-ministerial body, made up of the Ministries of Finance, Environment, and Economy, Development and Tourism created in 2023 in response to the biodiversity loss crisis and the need to incorporate the value of nature and the ecosystem services it provides in the country's sustainable development. **Decree No. 25, 2023, the Ministry of Finance of Chile.**

Specifically, the pilot project:

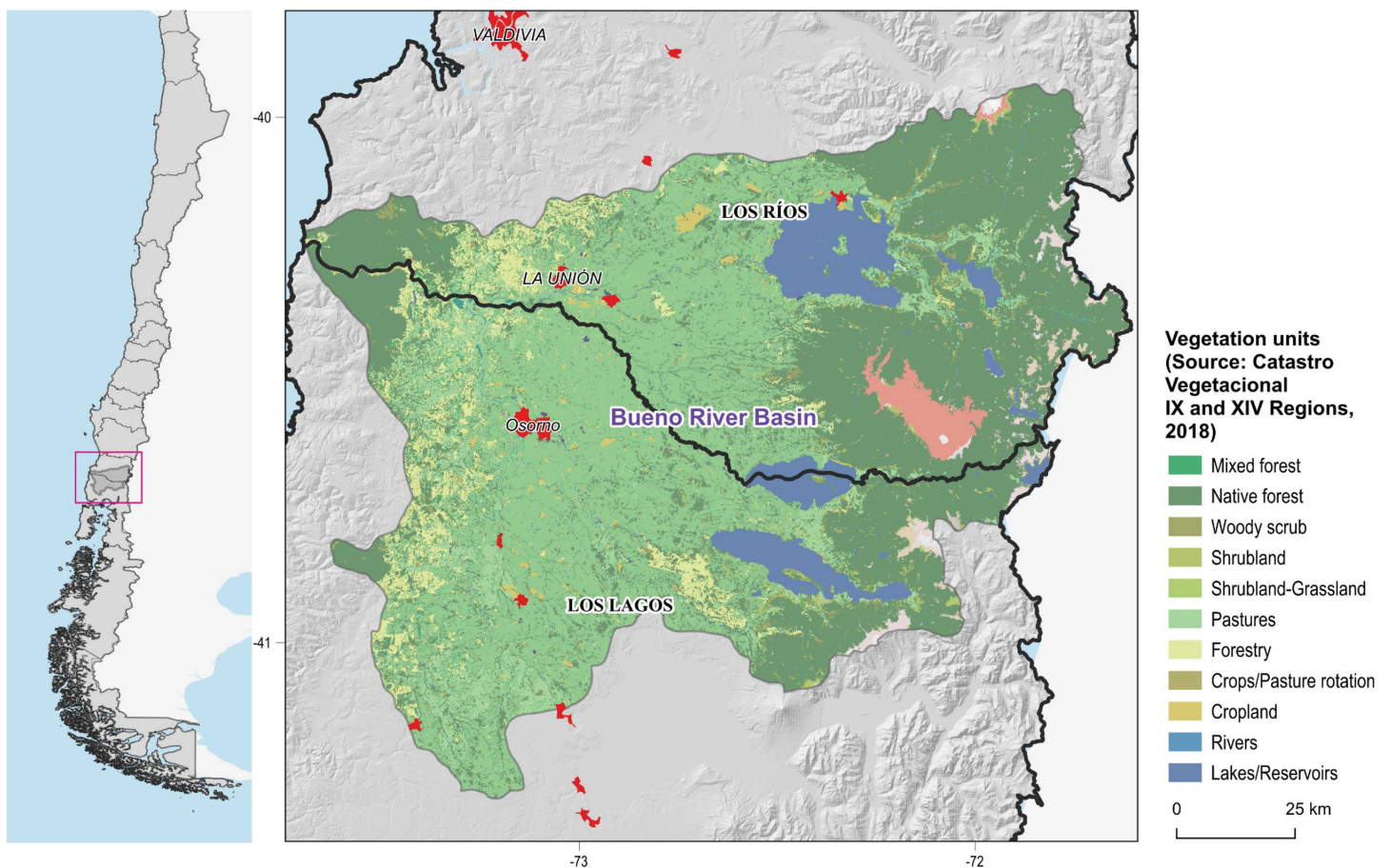
Establishes a framework for measuring, mapping, and valuing natural capital focused on ecosystem services relevant to planning, environmental management, and public investment, at the subnational scale.

Provides recommendations for scaling up the application of NCA in policy coordination.

Generates technical inputs for the advancement of the recently regulated Biodiversity Offsets Instrument, its articulation with other mechanisms of the SBAP, and its coherence with existing management and evaluation tools.

Strengthens institutional capacity through joint work with the NCC and other entities.

**Figure 1:** Map showing the distribution of the main components of natural capital in the Río Bueno basin, based on the inventory of vegetation resources in the Los Ríos and Los Lagos regions<sup>5</sup>.



5 CONAF (2024). **Land Use and Vegetation Resources Cadastre of Chile: Los Ríos and Los Lagos Regions**



By identifying and quantifying ecosystem services, the initiative generates actionable, traceable, and policy-relevant information within environmental assessment procedures and compensation mechanisms, and supports other SBAP instruments, such as ecological planning,<sup>6</sup> certifications,<sup>7</sup> and remuneration for ecosystem services.<sup>8</sup>

Moreover, the project consolidates an iterative process that connects advances in information and knowledge of natural capital with concrete inputs for the design, implementation, and monitoring of policies.

The analysis of opportunities for the integration of NCA in Law No. 21,600 and its regulations — especially in the Biodiversity Offsets Instrument — is supported by the **principle of valuation of ecosystem services**,<sup>9</sup> which obliges the SBAP to consider the identification and valuation of ecosystem services in its decisions on ‘biodiversity conservation’. This encompasses the maintenance of the structure, composition, and function of ecosystems through the protection, preservation, restoration, or sustainable use of one or more components of biological diversity.<sup>10</sup>

Specifically, the project provides key inputs to the SBAP at three levels:

### 1. Specific to the Biodiversity Offsets

**Instrument:** guidelines and analyses to guide the identification of offset sites, including restoration co-benefit areas.

**2. Across the SBAP:** methodologies, criteria, and evidence applicable to ecological planning, certification, compensation, and remuneration for ecosystem services.

**3. Coherence with other instruments:** contributions to aligning biodiversity offsets and SBAP instruments with water, climate, and local and regional development agendas.

This report synthesizes the methodologies, activities, and results obtained in the evaluation of the natural capital of the Río Bueno basin, together with inputs for integration with policy instruments. Technical documents that delve into each component of the project —biophysical and economic modeling, spatial analysis, design and implementation of instruments and policy recommendations— are referenced to facilitate use by relevant institutions and scaling to other basins and regions.

6 Ecological Planning (Art. 28 Law No. 21,600)- Identifies priority sites for conservation and guides the updating of local planning instruments.

7 Certification System for Biodiversity and Ecosystem Services (Art. 51 Law No. 21,600)- Establishes voluntary certifications for actions that restore biodiversity and ecosystem services.

8 Payment for Ecosystem Services (Art. 52 Law No. 21,600) – Regulates payment contracts between suppliers and remunerators to conserve ecosystems and ES.

9 The Law for Nature (No. 21,600), in its Article 2 on guiding principles, establishes that the policies, plans, programs, norms, actions and administrative acts issued within the framework of this law for the protection and conservation of biodiversity shall be governed, among others, by the principle of valuation of ecosystem services. This principle indicates that the decision-making process for conservation should consider the identification and valuation of ecosystem services and, where possible, their quantification.

10 Definition of Article 2 of the Biodiversity Compensations Regulation, letter d) “Key components of biodiversity: elements of biodiversity that are fundamental for the conservation of the diversity of the same species, between species and between ecosystems and their interactions with the biotic and abiotic environment, either because of the intrinsic values and/or ecosystem services they provide”.

## Box 2

The pilot project in Chile was developed under the **Regional Technical Cooperation (TC) 'Transforming policies and investment through the integration of rapid approaches to Natural Capital Assessment and Accounting.'** This TC was funded by the Global Environment Facility (GEF); implemented by the Inter-American Development Bank (IDB) and the technical work was led by the Natural Capital Alliance (NatCap), formerly known as the Natural Capital Project, at Stanford University. The main beneficiaries and co-designers of this TC in Chile are the Natural Capital Committee (NCC) – an inter-ministerial body made up of the Ministries of Finance, Environment, and Economy, Development and Tourism, with advice from the Central Bank (BCCh) and the National Council of Science, Technology, Knowledge and Innovation for Development (CTCI). This work also received funding from the Gordon and Betty Moore Foundation. **More information about the project's applications can be found [here](#).**

This project in Chile is also part of the People, Planet, Prosperity (3Ps) project, through which NatCap, based at Stanford University, collaborates with the IDB, the Asian Development Bank (ADB), and the World Bank on pilots in 16 countries, to expand the use of NCA worldwide. For more information check out the 3Ps project page [here](#).

# Glossary of Key Terms

In this report we use the following terminology:

**Beneficiaries:** The specific people, groups, sectors, or organizations that receive the benefits of ecosystem services. More specifically, they are all socio-economic units that benefit from ecosystem services.

**Cultural Ecosystem Services:** Non-material benefits derived from the relationship between people and ecosystems, including cultural identity, spiritual values, traditional knowledge, recreation, education, and well-being. They are often more difficult to quantify and value in monetary terms, requiring qualitative, participatory, and deliberative approaches.

**Ecosystem Services (ES):** Refers to the material, spiritual, cultural, community and other benefits that ecosystems provide to people. Formally, it refers to 'the contributions of ecosystems to benefits that are used in economic activity and

other human activities.'<sup>11</sup> These services include the provision of goods, regulation of natural systems, and cultural services.<sup>12</sup> They also cover the conservation of options for the future, such as genetic diversity for potential uses (such as the development of scientific research).

**Natural Capital (NC):** The Earth's natural assets – its lands, waters, and biodiversity – on which all life depends. Formally, it refers to the reserves of natural assets (renewable and non-renewable) that provide a flow of ecosystem goods and services for human well-being and economic productivity.<sup>13</sup> These assets include biological resources, terrestrial and aquatic areas with their ecosystems, minerals, soils, and air, which are essential for economic production, the maintenance of life, and the quality of natural environments.

11 System of Environmental-Economic Accounting – **Ecosystem Accounting (SEEA-EA)**, United Nations, 2021.

12 Comité de Capital Natural. (2023). **Informe Anual del Comité de Capital Natural 2023**. Ministerio de Hacienda, Chile

13 Dasgupta, P. (2021). *The Economics of Biodiversity: The Dasgupta Review*. HM Treasury, UK.



**Natural Capital Approaches (NCA):** Approaches that make explicit the benefits of nature for people and economic activity, so that they can be incorporated into decisions and can motivate investments or ecosystem management decisions, improving the well-being of both people and nature.

**Natural Capital Assessments:** These quantify and map natural capital stocks and ecosystem services flowing to people, to provide quantifiable—and often spatially explicit—metrics of those services, whether monetary, biophysical, or social/cultural. Through the characterization of ecosystem service flows, assessments seek to answer questions such as: **where do ES originate; who are their beneficiaries; how do different sectors and human activities perceive these benefits; how much value do they generate at the local, regional and national level; and how can these benefits change when changes occur in ecosystems or in the use of services by society?**

**Provisioning Ecosystem Services:** Material goods obtained directly from ecosystems, such as food, water, fibers, wood, energy and fuels, genetic resources, and inputs for production. They usually have more direct information for their quantification and economic valuation.<sup>14</sup>

**Regulating Ecosystem Services:** Benefits derived from the regulation of ecological processes, such as climate and water regulation, purification of pollutants, sediment retention, pollination, and pest and disease control. Its economic valuation is usually indirect and depends on biophysical models and baseline assumptions.

**Valuation:** A component of many natural capital assessments and accounting that focuses on providing quantitative estimates for relevant ecosystem services. These values can be monetary or non-monetary. A natural capital assessment could assess the potential supply of ecosystem services (e.g., where waters originate in a watershed); the effective utilization of the service by human or economic activities (e.g., how much water flows to specific communities or uses); or estimate values (e.g., what is the monetary value created by that water for that specific community? Or how many people have changed access to clean drinking water?).

## Acronyms

SBAP	Servicio de Biodiversidad y Áreas Protegidas ( <i>Biodiversity and Protected Areas Service</i> )
SEA	Servicio de Evaluación Ambiental ( <i>Environmental Assessment Service</i> )
SMA	Superintendencia del Medio Ambiente ( <i>Superintendence of the Environment</i> )
DGA	Dirección General del Agua ( <i>General Water Directorate</i> )
SAG	Servicio de Agricultura y Ganadería ( <i>Agricultural and Livestock Service</i> )
CONAF	Corporación Nacional Forestal ( <i>National Forestry Corporation</i> )
UICN	International Union for Conservation of Nature
SEIA	Sistema de Evaluación de Impacto Ambiental ( <i>Environmental Impact Assessment System</i> )

<sup>14</sup> Explanation based on [Millennium Ecosystem Assessment \(2005\). Ecosystems and Human Well-being: Synthesis](#). World Resources Institute.

# Process and Methodology

## Box 3

The use of Natural Capital Approaches (NCA) involves iterative processes of engagement and consultation with a diversity of people and sectors. Each stage may require different types and levels of involvement. Overall, these participatory processes are an effective way to incorporate reliable scientific information as part of good governance, carried out by governments, NGOs, the private sector, civil society, and multilateral development banks. It is essential that at least one – and hopefully more – of the people involved become true champions or local leaders of this work, contributing their networks and capacity for influence, and committing themselves to the long-term success of the initiative. The participation process is based on building relationships of mutual respect and the clear definition of deadlines and objectives, and includes, in many cases, intercultural exchange and learning, which takes time, but is often valuable and meaningful in multiple ways.

The development of the project was based on a collaborative approach across the NatCap team, the NCC, the IDB, and key actors at the national and regional levels. Throughout the process, the integrated team defined priorities, validated methodological assumptions, discussed preliminary results, and adjusted the analyses to the needs and opportunities for public policy advancement and management. This approach made it possible to integrate scientific knowledge with local and institutional knowledge, strengthening the relevance and applicability of the products generated. The complementary roles between institutions facilitated uptake of the results and laid the foundations for future scaling.

In the process and methodological scope of the project, presented in Figure 2, the biophysical, economic, regulatory, and institutional components were integrated with the aim of generating concrete inputs that facilitate the adoption of NCA in decision-making at different levels of public policy. The project also incorporates a capacity building dimension in a cross-cutting way aimed at strengthening the understanding and use of the methodology and products generated throughout the different stages of the process.

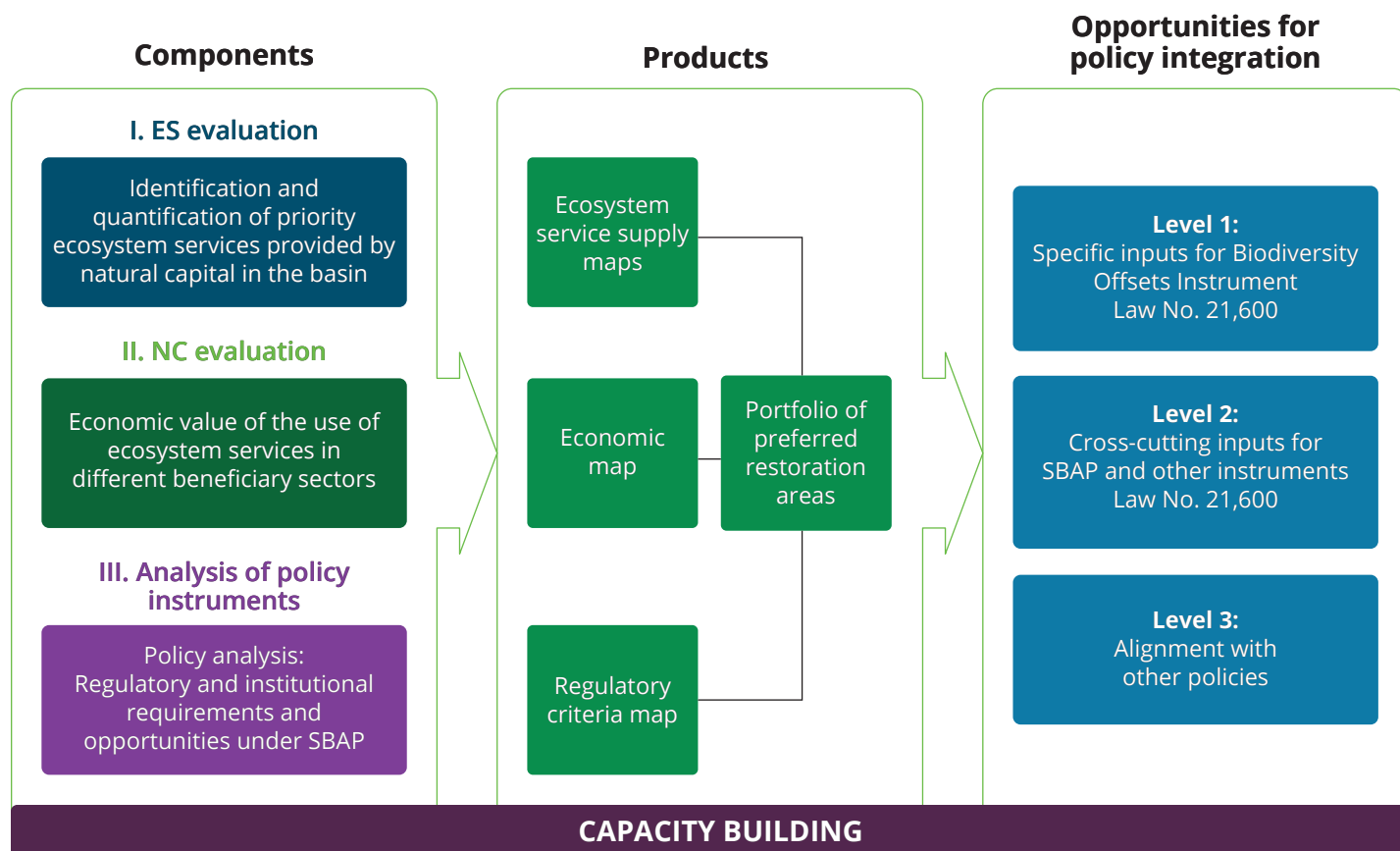
The project was structured around three core components:

- **Ecosystem services assessment:** identifies the supply and use of ES in the Río Bueno basin, estimating where they are generated, how they function, and who benefits from them.
- **Economic valuation:** develops an evaluation framework that translates these biophysical benefits into comparable monetary metrics by estimating the Total Economic Value (TEV) of the prioritized ecosystem services in the basin.
- **Policy instrument analysis:** reviews relevant instruments and incentives linked to natural capital and ecosystem services, with an emphasis on the regulations of Law No. 21,600, to identify information requirements, gaps, opportunities, and specific avenues for implementation.

This methodological process included participatory workshops with public institutions and local actors at different stages of the analysis.



Figure 2: Summary table of the project's process and methodological scope.



Four main spatial products were developed from these components:

- **Maps of ES potential supply:** these show the spatial distribution of where different services are generated by nature across the basin, information that is then complemented with data on the actual use of ES, i.e., who receives them and how they depend on them.
- **Economic map:** with the supply and use of the ES, physical and monetary magnitudes of the flows are estimated, reflecting estimates of their contribution to local economic activity. These values are represented spatially on a map constructed from the valuation in monetary units of the interactions between provider and beneficiary areas. By expressing this in homogeneous units (USD per hectare) and aggregating multiple services, this map illustrates the areas of the basin where high levels of ES supply co-occur and there is a high dependence on them by the beneficiaries, thus highlighting hotspots of ecosystem services value.
- **Regulatory criteria map:** this combines the criteria in the Biodiversity Offsets Regulation – representativeness, uniqueness, extent remaining, and transformation – and translates them onto a map of the basin, showing the spatial distribution of the preferred areas for biodiversity restoration.
- **Portfolio of preferred restoration areas:** based on the information generated by the previous products, an optimization analysis identifies where biodiversity restoration actions maximize the co-benefits of ES and minimize the opportunity cost. This information, in turn, is combined with the maps of normative criteria and the economic valuation of the gains (or losses) of ES to identify a portfolio of preferred areas for restoration, as an input to guide cost-efficient decisions that offset biodiversity losses while also meeting other societal objectives, such as water security and climate mitigation.

These outputs serve as spatial inputs for the integration of the NCA into public policies at three levels: a direct link with the **biodiversity offsets instrument**; cross-cutting contributions to other SBAP instruments; and coherence with broader sectoral policies in water, climate, and development planning. The combined use of the products generates **an evidence base for a coherent approach across ecological, economic, and regulatory dimensions**, to

guide restoration decisions, identify preferred areas that achieve different objectives, and strengthen the traceability, coherence, and effectiveness of public policy.

The three components of the project and their associated outputs are presented in the **Technical Results** section of this report.



Photo Credit: Nadine Trahan.



# Technical Results

Below are the technical results and each of the outputs laid out in Figure 2.

## Component I – Assessment of priority ecosystem services

The project team, in collaboration with public institutions and other relevant sectors, evaluated six ES at the local level for which there is sufficient biophysical and socio-economic information, and which are also particularly relevant to strategic sectors of the basin, such as rural and urban drinking water, agriculture, energy, forestry, and tourism. In general, data generated by national and regional institutions in Chile was prioritized; however, in some cases, this was supplemented with data from global sources. Box 1 details each of the selected ecosystem services. The complete list of data sources used can be consulted in [Technical Annex 1: Economic and Spatial Dimensions](#).

While the list of ES analyzed is relatively short, it offers a variety of relevant benefits, including provisioning, regulatory, and cultural. At the same time, it allows for demonstrating and differentiating the many roles of

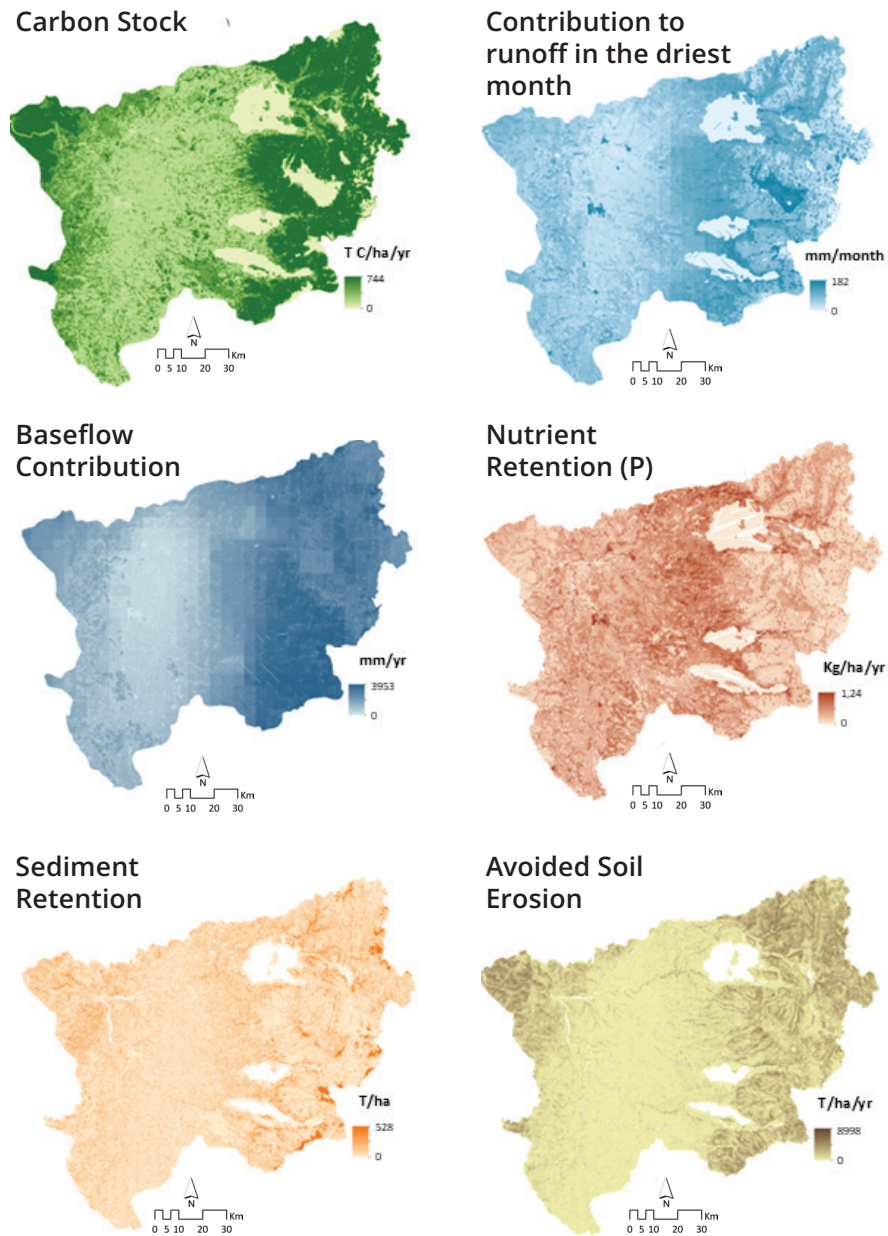
ecosystems in functions that people typically group into one category. For example, several of the services considered have an influence on different dimensions of water security, related to the quantity of water (i.e. sufficient water supply), quality (i.e. pollution regulation) and reliability of supply (i.e. maintenance of stable flows during dry periods). Among these different ecosystem contributions there are interactions, which are relevant to informing decision-making in order to manage natural capital in an efficient and balanced way according to social and economic priorities and prerogatives. Once the ecosystem services were defined, the team built a technical framework to measure, map, and understand these prioritized services. The analysis is based on land use/land cover maps that allow for identifying the distribution of ecosystems, other key components of the landscape, and other sources of biophysical information such as climatic, topographic, and soil data to estimate the potential supply of ES (in physical units).

**The methodology is detailed in Box 4.**

### Output 1 – ES Supply Maps

The team produced maps of the potential supply of different ES across the basin (Figure 3).

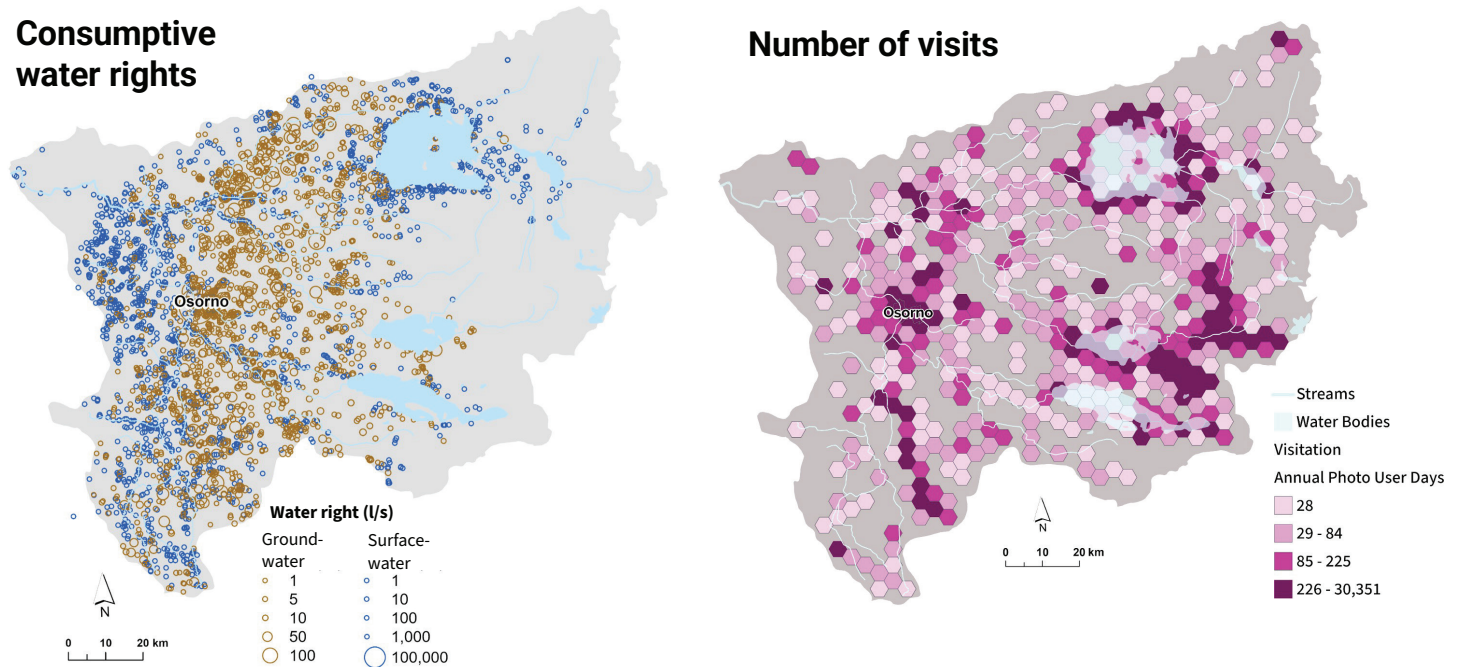
**Figure 3:** Maps illustrating the potential supply<sup>15</sup> of different ES evaluated in the Río Bueno basin.



<sup>15</sup> The ES shown in this figure were quantified with respect to the baseline defined by the Ecosystem Accounting Framework of the System of Economic Environmental Accounting (SEEA-EA). These ES estimates compare the current potential provision of ES with respect to a baseline level of ecosystem condition that will generate the lowest possible level of service provision, i.e. a degradation scenario. For multiple ES, the baseline corresponds to zero. For example, the carbon storage service in an ecosystem is zero if vegetation biomass is completely lost and soils and organic matter are eroded and degraded. In other cases, such as services related to avoided erosion, the baseline corresponds to the condition of absence of vegetation, as would be the case of bare soil that is highly susceptible to erosion and lacks vegetation to retain sediments originating uphill. For services associated with the maintenance of water quantity, such as contributions to base flows (or aquifer recharge), the baseline reflects the condition of soil and vegetation degradation that prevents the infiltration, recharge and/or storage of subsurface water, limiting its operation as a natural reservoir that maintains flows in water sources during dry seasons.



**Figure 4:** Location maps in the basin of the different beneficiaries or showing use of ecosystem services. Left: Consumptive water rights in the Río Bueno basin (Source: DGA, 2024) and Right: Index of number of visits to the area, including its natural areas (Derived from the geolocation of photographs reported by visitors on the social network Flickr).

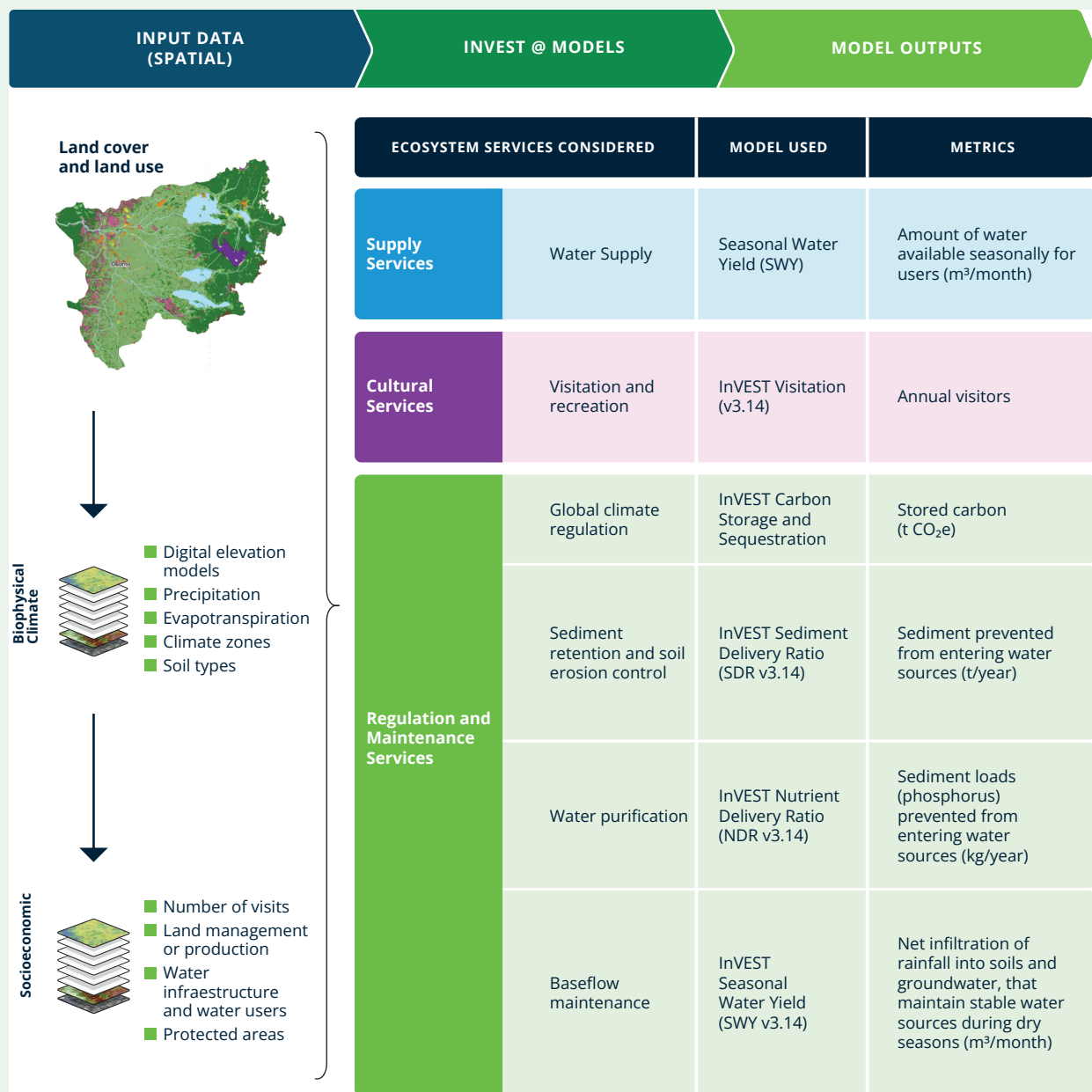


\* Each user-day corresponds to a unique user who uploaded at least one photo on a specific day. Multiple users on the same day or the same user on different days are counted separately.

#### Box 4

Methodology and tools used to assess the supply and use of ES

**Characterization of the potential supply of ES:** InVEST (Integrated Assessment of Ecosystem Services and Trade-offs) tool was used, a free and open-source software suite developed by NatCap at Stanford University. This tool allows for the spatial integration of different sources of environmental and socioeconomic information and the identification of ecosystems that provide different services. The following figure summarizes the InVEST models and the unit of measurement for ecosystem services in each model. It should be noted that the habitat ecosystem service is not based on InVEST, as supply is estimated directly as the existence of vegetation units or natural wetlands. A complete description of the information sources and analysis methods used is available in [Annex 1: Economic and Spatial Dimensions](#).



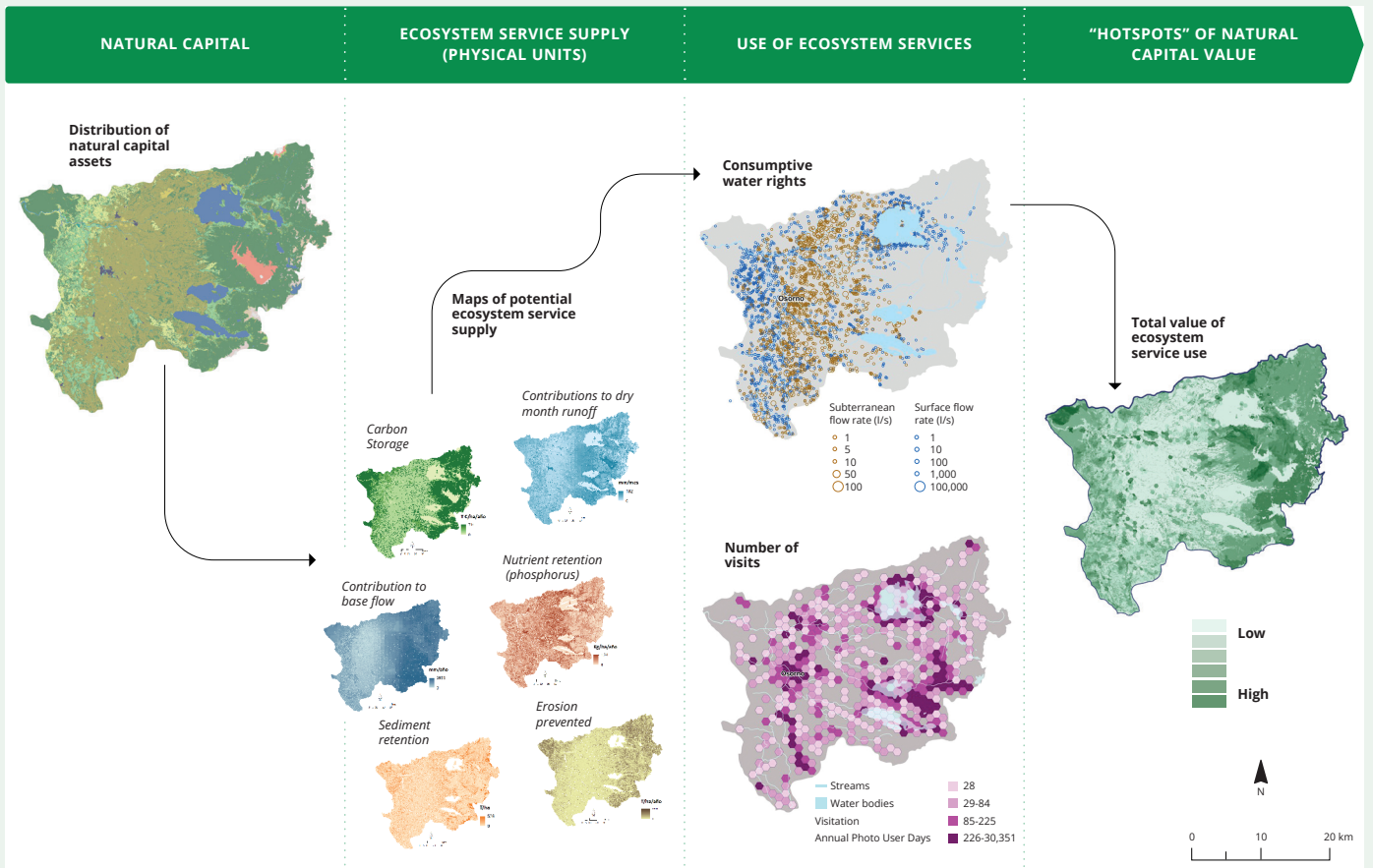
**Characterization of the use of ES:** The potential supply is then evaluated against the actual use of ES. To this end, different sources of socioeconomic information and roundtable discussions with local stakeholders are used to characterize the dependence and social benefits associated with each ecosystem service. This includes, for example, in the case of water-related services, the location and type of consumptive water rights, differentiated by type of user (human consumption, agriculture, hydroelectric power, etc.). In the case of visitation or recreation services, the number of visits to different natural areas such as forests, lakes, etc. is used.

Both supply and use can be estimated in physical units (e.g., in terms of quantity and quality of available water, number of visitors to natural areas, amount of carbon storage for global climate regulation, among many others), or by applying economic valuation techniques, in monetary units (Chilean pesos).



**Mapping value hotspots:** Finally, the results of supply and current use were integrated to generate maps highlighting areas with high natural capital value based on the current use of the services considered.

Process of modeling and assessing the potential supply and use of the selected ES in the Río Bueno basin.



**Figure 5:** Project team meeting with representatives of the Mashue Rural Drinking Water Association to learn about their perspectives on the contributions of ecosystem services to water quantity and quality, and the association’s activities to protect and restore native forests.



Photo credit: Nadine Trahan.

## Component II – Economic valuation

The valuation of ES in the Río Bueno basin is based on the Total Economic Value, calculated as the product of the amount actually used and the monetary value per unit of ES. The methodology followed three steps: identifying benefits (use and non-use values) using available socioeconomic information and interviews with local actors; estimating the actual use of ES by beneficiaries, incorporating spatial variability and context; and monetizing each service using appropriate

methods and local data, considering rivalry/non-rivalry<sup>16</sup> and, where appropriate, socioeconomic adjustments. This approach made it possible to compare the relative economic magnitude of the different services. Table 1 summarizes the economic valuation methods used. Methodological details and the justification for each valuation technique can be found in [Technical Annex 1: Economic and Spatial Dimensions](#).

**Table 1.** Valuation methods selected for the services evaluated in the Río Bueno basin.

Type of Ecosystem Service	Element of nature that generates the benefit	Process that determines the service	Valuation method implemented	Metric
Water supply (quantity)	Forests, wetlands, vegetation that infiltrates water, soils, and natural hydrology	This corresponds to the capacity of ecosystems to make fresh water available for users for different purposes, from consumption to irrigation	Market values of water rights	Cubic meters of water available annually (m <sup>3</sup> /year)
Water Regulation	Soils, vegetation (forests, scrubland, and grasslands/or vegetation alone), wetlands, aquifers.	This refers to the capacity of ecosystems to store water and release it gradually, mitigating the variability of flows between the rainy and dry seasons.	Replacement cost, market value	Volume of water stored by soils and aquifers during the wet season, which remains available during the dry season (mitigation of flow variability) (m <sup>3</sup> /year)
Water Purification—Sediment and Nutrient Retention (P)	Vegetation that protects the soil, roots, vegetation cover, stable soils. The value of the ecosystem service	The value of the freshwater purification ecosystem service is estimated based on the capacity of ecosystems to prevent erosion and retain sediment and nutrients that would otherwise reach water bodies, affecting their quality	Avoided costs, replacement costs	Mass of sediments (tons/year) and nutrients (kg/year) retained

<sup>16</sup> A rival good or service is one whose use by one person reduces or prevents others from consuming it at the same time (e.g., water used for irrigation in agriculture). On the other hand, a non-rival service can be used by several people simultaneously without decreasing availability to others (e.g., water quality).



Type of Ecosystem Service	Element of nature that generates the benefit	Process that determines the service	Valuation method implemented	Metric
Climate Regulation – Carbon Storage	Native forests, forest plantations, soils rich in organic matter	CO <sub>2</sub> capture, through carbon fixation, is a service provided by ecosystems that helps regulate the climate. Storage capacity varies depending on the type of ecosystem and its state of conservation.	Carbon storage value	Tons of CO <sub>2</sub> equivalent stored, annualized over a 50-year period (Ton CO <sub>2</sub> eq/year)
Habitat and Nurseries	Forests, wetlands, and natural ecosystems, especially those with high biodiversity or low disturbance.	Habitat can be considered a regulatory service, providing the necessary space for biodiversity and ecological balance.	Habitat Value Forests	Hectárea de bosques (Valor Transferencia de Beneficios)
			Habitat Value Wetlands	Hectare of wetland (Benefit Transfer Value)
Recreation	Natural landscapes, forests, lakes, rivers, protected areas, volcanoes, mountains, beaches	To quantify this service, a value is applied to the number of visits, based on the number of visitors and the expenditure per visitor per year	Expenditure per visitor, market value	No. of visitors per year

The estimated TEV of the ES for the Río Bueno basin amounts to **US \$496 million per year**<sup>17</sup>, considering the main service flows currently modeled and valued. These results provide a basis for establishing the economic value of the aggregate flow of benefits from the basin’s natural capital, without implying direct comparability between services, as estimates depend on the availability and detail of the information used for each one. The results reflect the diversity of ecological functions and their economic contributions at the basin level.

While some services have higher overall magnitudes (Table 2)—such as climate regulation, with more than \$220 million per year, driven by stable carbon storage in extensive areas of native forests—other services or ecosystems show high marginal values, even though their total contribution is lower in the table. This is the case for wetlands, which stand out for their unit value and for the set of ecological benefits they assemble in relatively limited areas.

It should be noted that preliminary results of the economic valuation were published in the document, **“Integrating Natural Capital into Public Policy: Lessons from the Río Bueno Basin,”** in January 2025. Subsequently, as a result of discussions on this document with key stakeholders, methodological refinements were applied to the valuation framework and adjustments were made to some key parameters, with the aim of improving the accuracy, comparability, and scalability of the economic estimates of the modeled ecosystem services. In particular, refinements were incorporated to strengthen the consistency of the economic analysis for water regulation and water quality services, including sediment retention and nutrient (phosphorus) retention.

<sup>17</sup> A sensitivity analysis was carried out for which the total value can be up to 2.2 billion dollars per year. For more details, see **Technical Annex 1: Economic and Spatial Dimensions.**

**Table 2.** Total Economic Value (TEV) of ecosystem services in the Río Bueno basin, based on current usage conditions.

Type of Ecosystem Service	Valuation Method	Unit Value	Unit	Annual Value USD/year
Water supply (quantity) USD/m <sup>3</sup>	Production functions, market values of water rights	0.013 (sufficient supply) 0.035 (shortage)	USD/m <sup>3</sup>	60.621.766
Water Regulation	Replacement cost, market value	0,041	USD/m <sup>3</sup>	20.589.779
Water Purification – Sediment Retention	Avoided costs, replacement costs	0,0853	USD/kg	127.643.904
Water purification – Nutrient retention	Avoided costs, replacement costs	158,16	USD/kg	7.855.819
Climate Regulation 5 USD/ Ton CO <sub>2</sub> eq 223,323,479	Carbon Storage Value	5	USD/Ton CO <sub>2</sub> eq	223.323.479
Habitat and Nurseries	Habitat Value Forests	509,710	USD/ha/year	49.358.772
	Habitat Value Wetlands	976,280	USD/ha/year	1.974.224
Recreation	Spending per visitor, market value	186,17	USD/visit	4.756.842
				<b>496.124.585</b>

As other service flows are evaluated — for example, other components of water quality in addition to avoided phosphorus, or services currently under development, such as pollination — it is reasonable to expect an increase in the estimated economic value. Furthermore, there are cultural ecosystem services that were not included in this estimate, such as those associated with cultural identity, traditional ecological knowledge, the use and preservation of local seeds, and the symbolic or spiritual values of the landscape, which are especially relevant in contexts where Indigenous communities are present. The values presented therefore constitute a conservative economic assessment based on a subset of associated social and cultural values that depend on nature. Nevertheless, it offers a starting point for the significant magnitude of the economic contributions of natural capital in the Río Bueno basin.

## Output 2 – Economic map

The economic map integrates the six ES using a weighted additivity scheme, expressed in Equivalent Annual Costs (EAC) of the aggregate flow of ES, expressed in USD/ha/year. The result combines the biophysical provision of ecosystem services with their effective use, explicitly incorporating the spatial interaction between the areas where ecosystem processes are generated and the beneficiaries of the services. In this way, the economic map reflects the spatialized economic value associated with this interaction, and not only the location of the ecosystems.

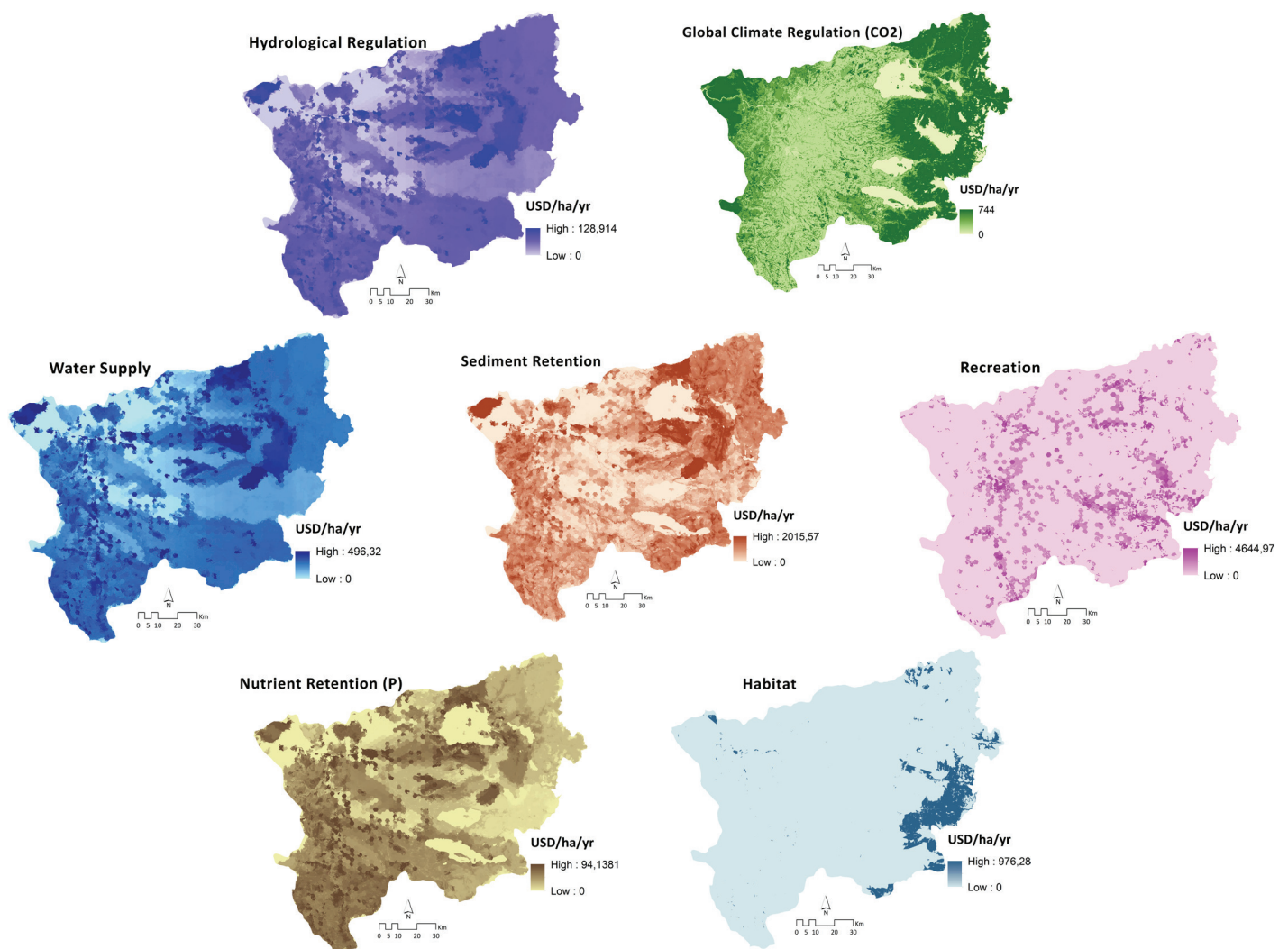
The resulting output functions as a map of ‘hotspots’ of natural capital benefit flows (Figure 6), which allows for the visualization of the spatial distribution of the value of ES generated by different areas of the basin, based on their use by different economic sectors. In other words, it illustrates those areas of the landscape where economic interdependencies converge with ecosystem functions.



The spatial attribution of economic values developed is based on the SPA-SBA-SCA<sup>18</sup> framework, which allows the value perceived by each beneficiary of an ecosystem service to be linked to the places that generate it. For each beneficiary, the service-providing area that is causally and spatially connected to each service beneficiary is first delimited. For directional

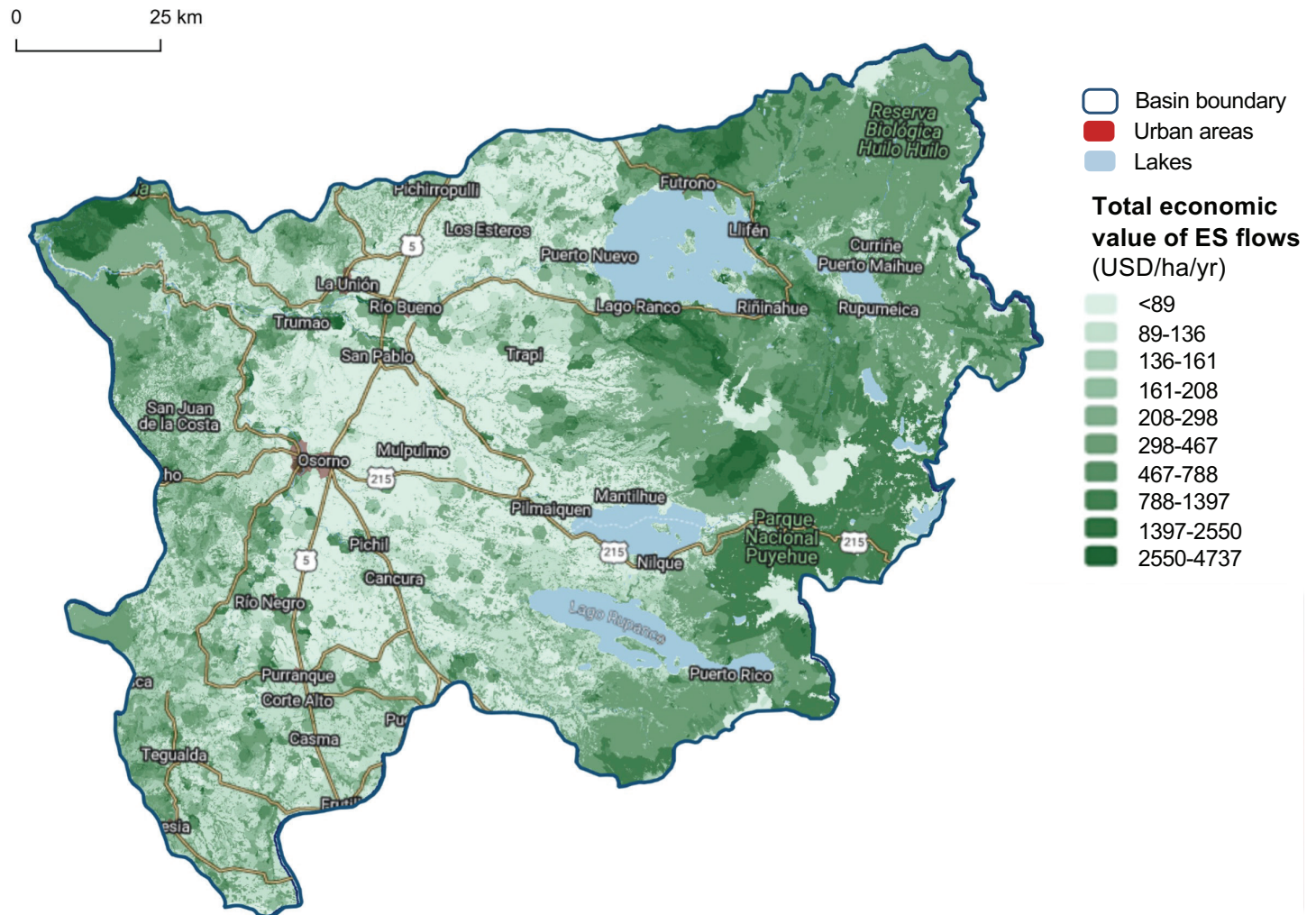
services such as water supply, the service connection area, i.e., those hydrological sub-basins that are connected to the beneficiaries, is also considered. This step ensures that only areas with an actual flow or connectivity between potential supplier areas and users are considered.

**Figure 6.** (First image) Maps showing the economic value contributed by different areas according to the supply and use of ecosystem services (monetary values per hectare) based on the current supply and use of all six ecosystem services evaluated. (Second image) Map showing the total economic value of the ecosystem services evaluated in the basin (TEV).



18 Syrbe, R. U., & Grunewald, K. (2017). Ecosystem service supply and demand – the challenge to balance spatial mismatches. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 13(2), 148–161. <https://doi.org/10.1080/21513732.2017.1407362>

Figure 6 continued



The result, shown in Figure 6, represents significant spatial heterogeneity, influenced not only by land use type, but also by the biophysical, ecological, and demand conditions associated with each service. **Some areas stand out as particularly valuable according to this study, considering the set of services and the methodology applied: the edges of Lake Ranco, the surroundings of Lake Puyehue, the areas adjacent to the Río Bueno, and the northern sector of the Coastal Range.** In general, the areas closest to both the Andes and the coastal mountain ranges have the highest values, corresponding to the presence of native forest ecosystems that sustain higher levels of biophysical service provision, while also benefiting people downstream.

The eco-spatial analysis shows that many ES operate jointly and tend to form patterns of concurrent use. In several sectors of the basin, increases in carbon storage, sediment retention, and nutrient retention occur simultaneously, evidencing natural synergies between ecological functions that sustain stability in water supply and quality, climate regulation, and the provision of cultural visitation services. These groupings suggest that vegetation cover and landscape dynamics not only produce individual benefits, but also bundles of services, whose integrated understanding allows for a more complete reading of ecosystem and social interactions and dependencies, and of opportunities for coordinated management based on multiple co-benefits.



## Component III – Analysis of policy instruments

The policy instrument analysis component was structured around four complementary methodological pillars.

First, an institutional mapping and inventory of public policies was carried out, which systematized 233 regulatory instruments, programs, and policies related to biodiversity, water, forests, and land use planning, identifying overlaps, gaps, and opportunities for coordination (the results can be reviewed at: [visualization tool for the inventory of public policies associated with natural capital](#)). Second, a **regulatory review and analysis of institutional coordination** was carried out, examining Law No. 21,600, the interaction between its instruments, and a detailed review of the selection criteria for preferred sites in the Biodiversity Offsets instrument to assess its consistency and integration in the basin, as well as the interactions of the offsets instrument with the Environmental Assessment Service (SEA) methodological guidelines and Sectoral Environmental Permits (PAS). The third pillar corresponded to **gathering input**, through regional workshops and interviews, with relevant actors from the SBAP, SEA, SMA, DGA, SAG, CONAF, and Regional Governments, which allowed for the validation of real information needs, operational gaps, and institutional requirements for applying the instrument. Finally, an **analysis of the offsets plans** of the Environmental Impact Assessment System (SEIA) was carried out, reviewing eight Environmental Impact Studies approved for the basin in the last decade to identify current practices, trends in functional offsets, inclusion of cultural and support ES, and the

magnitude of investment in offsets. The entire process and details of the activities carried out within the regulatory and institutional analysis are detailed in [Technical Annex 2: Analysis of Policy Instruments](#).

The work carried out complements the ES assessment and economic valuation components and served as an input for the spatial integration of the biodiversity offsets regulation criteria, for the optimization model, and for the identification of opportunities for integrating natural capital into the offsets instrument and other SBAP mechanisms.

### Output 3 –Regulatory criteria map

A map to summarize the four criteria established by the Biodiversity Offsets Regulation that must be met when implementing offsets within the SEIA framework (Representativeness, Singularity, Extent Remaining, and Transformation<sup>19</sup>) was developed and integrated into a composite regulation priority index to show the relative weight these criteria have in different areas of the basin. Each criterion was spatialized on a Likert scale from 1 to 5 (see Table 3 and Figure 7), where lower values indicate higher offsetting priority. The criteria were then aggregated using a weighted combination so that the resulting value reflects their joint contribution to the priority of the regulation. In operational terms, the values of the intermediate maps were integrated to generate a composite priority index, using a Cobb–Douglas geometric mean, which means that low performance in any of the criteria reduces the final value of the index.

However, the Extent Remaining criterion did not maintain a weighting equivalent to the rest because, given the characteristics of the ecosystems, it showed a high correlation with the uniqueness criterion, skewing

<sup>19</sup> Article 24 of the regulation indicates the 4 criteria for the selection of compensation sites as follows:

- **Uniqueness:** the restricted or fragmented distribution of biodiversity components, where greater uniqueness gives greater preference.
- **Transformation:** the change over time of the biodiversity components in the site. Greater transformation implies greater preference for compensation.
- **Representativeness:** the relevance of the biodiversity components found in a site, considering their level of protection within the National System of Protected Areas. Less representativeness of the site implies a higher priority for compensation.
- **Extent Remaining:** the remaining proportion of biodiversity components with respect to their historical extension. A lower number gives greater preference.

the prioritization toward a single vegetation layer. For this reason, the weightings were adjusted, assigning 30% to each map of uniqueness, transformation, and representativeness and 10% to extent remaining.

Subsequently, this composite index was integrated with information from national and regional Priority Conservation Sites (PCS)<sup>20</sup>, considering for each spatial unit the higher value between the two, in order to reflect both compliance with the criteria of the regulation and the priority already established by existing conservation instruments through the PCS.

**Table 3.** Biodiversity offsets regulatory criteria spatially mapped for the Río Bueno basin.

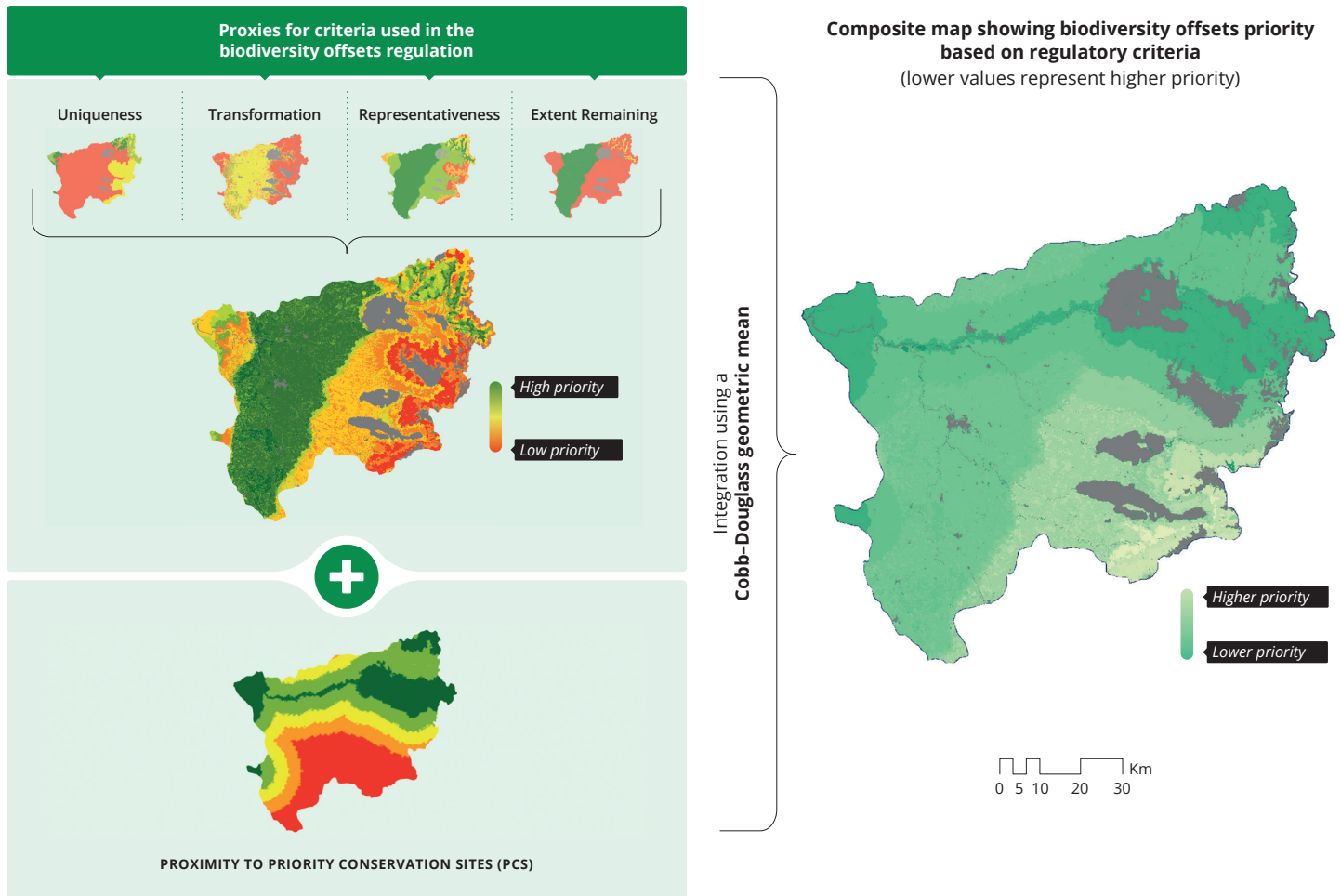
Criterion	Main source	Result
<b>Uniqueness</b>	National area of vegetation types (Luebert & Pliscoff 2017)	Map identifying the least represented vegetation types at the national level. A Likert scale of 1–5 was applied: 1 (green) = greatest uniqueness/rarity (high priority); 5 (red) = most common ecosystems (low priority)
<b>Transformation</b>	Difference between current coverage and potential coverage by vegetation formations	Map of the degree of structural transformation. Likert scale 1–5: 1 (green) = high transformation (greatest distance from the potential condition → high priority); 5 (red/white) = low transformation (“red does not change,” lower priority)
<b>Representativeness</b>	Protected proportion of each vegetation type in the National System of Protected Areas	Map of floors with low protection. Likert scale 1–5: 1 (green) = very low representativeness (<1.4%, high priority); 5 (red) = high representativeness (>46%, low priority), with adaptive thresholds according to actual distribution
<b>Extent Remaining</b>	Vulnerability of remaining ecosystems according to IUCN classification <sup>21</sup>	Vulnerability classification map. Likert scale 1–5: 1 (green) = CR [Critically Endangered]; 5 (red) = LC [Least Concern]
<b>Proximity to Priority Conservation Sites (PCS)</b>	Distance to SPC (buffers of 0–10–20–30 km)	Map of protected area influence. Likert scale 1–5: 1 (green) = within or very close to a PPA (<10 km, high priority); 5 (red/white) = >30 km (low priority)

20 Article 32 (of the biodiversity offsets regulation) deals with the determination of offset sites, it indicates that the SBAP may determine the sites according to Article 24 or in the biodiversity conservation priorities present in the ecological planning Article 28 of the Law. Article 28 will enter into force in 2028 according to transitory Article 8, which is why national and regional strategies were used to identify the priority sites in force and recognized in Law 19,300 Law on the Bases of the Environment (1994).

21 Biodiversity Information and Monitoring System for Ecosystems in CR Category and EN Category



Figure 7. Approach used to develop the biodiversity offset regulatory criteria map.



## Output 4 – Portfolio of preferred restoration areas

The restoration of natural habitats aimed at biodiversity objectives can generate additional benefits across various ecosystem services, such as carbon storage, sediment retention, water quality improvement, and flow regulation. However, these benefits are not distributed evenly across the basin, nor do they respond uniformly to the same interventions. The gain in the effective provision of each service depends on additional factors, such as the location of beneficiaries within a watershed, local biophysical characteristics, hydrological connectivity, and the relationship between provider areas and beneficiaries. In this context, the spatial correlations of restoration effects on ecosystem services may be low. For example, there are areas where the recovery of a forest or other native vegetation significantly increases

carbon storage but does not generate relevant changes in the water services perceived by beneficiaries, either because they are located downstream of already stabilized areas, because restoration occurs in sub-basins with low demand, or because the dominant hydrological processes are not sensitive to that particular land use change. This spatial heterogeneity makes it difficult to design restoration portfolios that simultaneously maximize benefits across multiple services, reinforcing the need for integrated approaches for local planning and prioritization.

Through a spatial optimization process, it is possible to identify areas of high frequency of choice in different scenarios, which align goals in several objectives simultaneously, minimizing opportunity costs so that the set of actions is economically efficient at the

watershed scale.

Within the framework of this project, a spatial optimization approach based on the Restoration Opportunities Optimization Tool (ROOT<sup>22</sup>) was applied to **identify areas of the Río Bueno basin where interventions aimed at restoring the original structure could be focused to maximize co-benefits from ES for the biodiversity, water, and climate agendas while minimizing the opportunity cost associated with the conversion of current uses or vegetation (e.g., in agricultural and forestry areas).**

The identification of preferred areas was informed by biophysical modeling of ecosystem service supply and use under a scenario of potential recovery of the territory's ecosystem capacity. The scenario used in the optimization analysis is based on the transformation of degraded or productive land (land uncovered under the tree line, agricultural land, scrubland, grasslands, forest plantations, among others) into the reference ecosystem corresponding to the vegetation layers of the basin. In this sense, the analysis assumes a hypothetical state in which these areas have been restored to their potential ecosystem condition, using the term 'restoration' in an operational sense, aimed at comparing states rather than explicitly modeling the ecological restoration process over time. The details

of the optimization approach, the assumptions used, limitations, and how it is applied are explained in **Technical Annex 1: Economic and Spatial Dimensions.**

**Main results of the optimization:**

1. **Co-benefits of restoration.** Figure 8 illustrates the relationship between the restored area (expressed in thousands of hectares) and the cumulative gain (or loss) in the potential provision of four ES,<sup>23</sup> measured as a percentage of the maximum possible change. At the individual level, for each ES (especially those where there are spatial dependencies between supply and use), the first interventions cluster the best opportunities and produce rapid increases in terms of benefits from some services; thereafter, marginal gains slow down as additional areas are restored. The agricultural opportunity cost is also presented in millions of USD per year, which increases with the expansion of the restored area as it involves land with higher productive value.

The pattern of 'diminishing returns' in benefits and increasing costs as restoration expands demonstrates the opportunity to strategically select biodiversity restoration sites aligned with the greatest gains in ES provision.

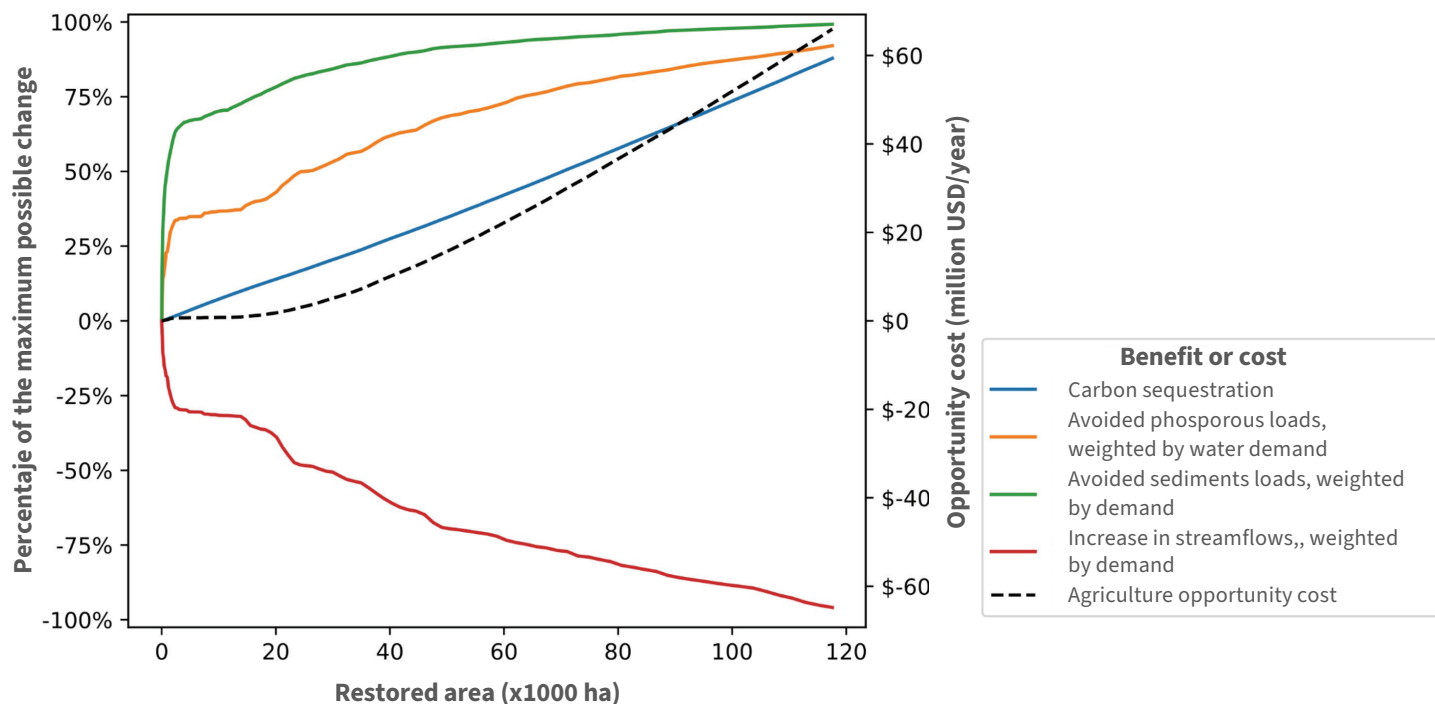
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22 **ROOT (Restoration Opportunities Optimization Tool)**, a spatial optimization tool developed by the Natural Capital Alliance that allows prioritizing restoration and conservation areas considering multiple objectives, environmental benefits and constraints, to support cost-efficient and evidence-based decisions. For more information review: **Aplicaciones de Restoration Opportunities Optimization Tool (ROOT)**

23 It should be noted that only those ecosystem services that present quantifiable variations under this scenario of recovery of the reference ecosystem, and that can be modeled consistently, were included in the analysis: water supply, sediment retention, nutrient retention, and carbon storage.



**Figure 8.** Estimation of benefits and trade-offs of ecosystem services, and the agroforestry opportunity cost, with respect to different combinations of preferences, conditioned on the maximum area to be restored equivalent to the conservation and recovery target associated with the 30x30 target,<sup>24</sup> of 117,546 hectares.<sup>25</sup>



**2. High overlap areas:** When evaluating different ES simultaneously (using a methodology based on varying the weights assigned to each service), some sites are repeatedly selected in the optimization process. These areas, shown in Figure 9, represent 'no-regret options,' i.e., sites where investing in restoration consistently offers simultaneous co-benefits for climate and water.

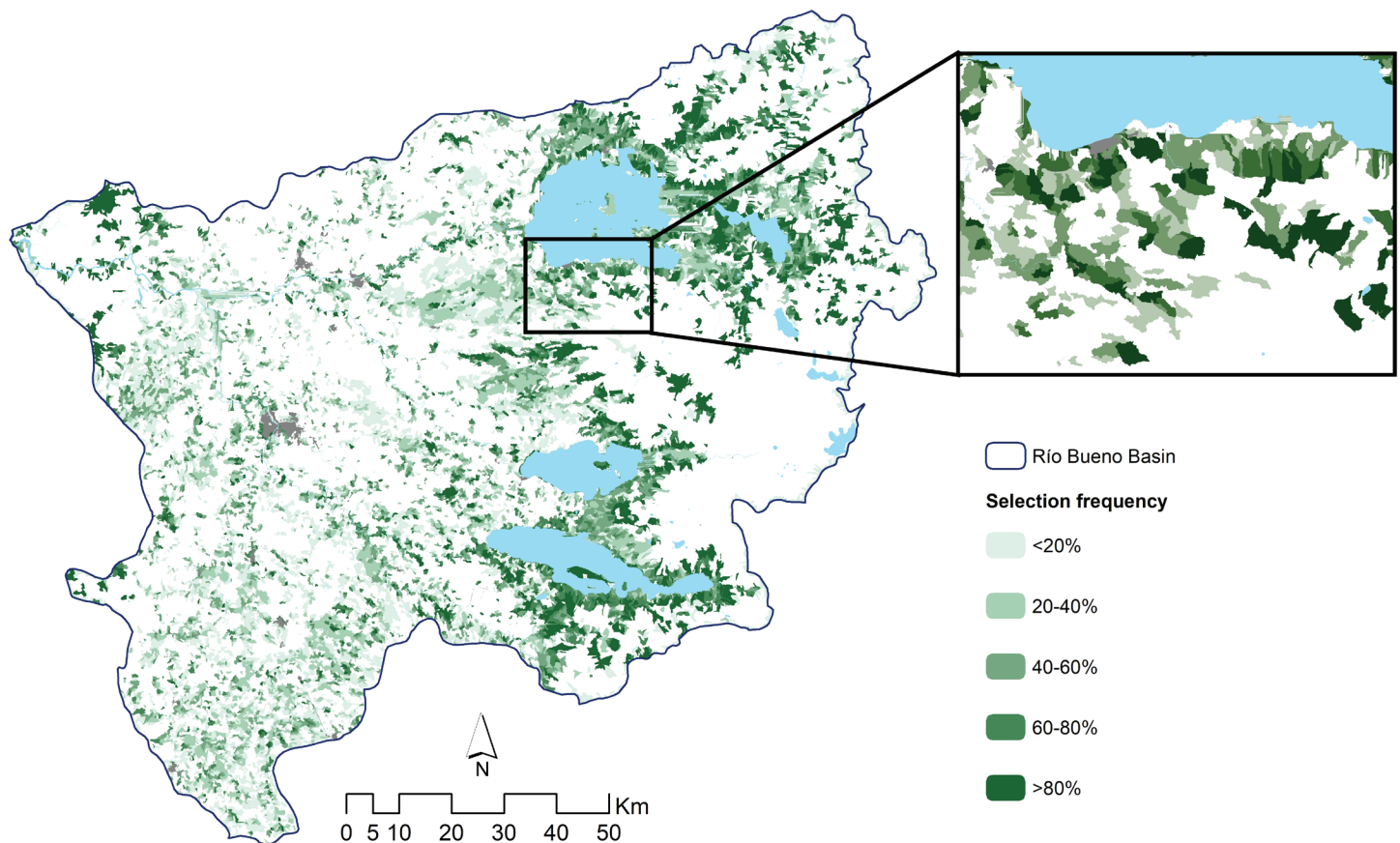
The most frequently selected decision units—the no-regret options—tend to be located in sectors of the transition between the Andes and the central

valley with medium-to-flat topography, where agricultural uses or grasslands predominate, but also in areas of transition to forested ecosystems, especially in the northern part of the basin and near Rancho Lake. This distribution indicates that sites with high restoration potential largely coincide with areas where the recovery of vegetation cover can generate significant benefits for the provision of ecosystem services, especially in sediment retention, nutrient reduction, and carbon sequestration.

<sup>24</sup> Protecting 30% of the planet's land and oceans by 2030. Roadmap 30-30 or Target 3 of the Global Biodiversity Framework (MMA, 2024).

<sup>25</sup> The 30x30 protection goal is the normative maximum number of a potentially restorable space (if one retains everything restored). This upper limit for optimization is useful because it allows establishing in the analysis the minor subsets of restoration area, such as the restoration goal of the basin.

**Figure 9.** Map of high coincidence areas, showing the frequency with which each micro-basin was selected in a restoration portfolio, using various combinations of ES provision level and opportunity cost.



### Integration of generated products

The integration of optimization results obtained through ROOT with regulatory biodiversity criteria and economic change associated with restoration allows for the identification of areas where different priorities coincide: ecological, economic, and regulatory. This intersection offers a more robust understanding to guide restoration interventions that produce multiple benefits and, at the same time, are consistent with public policy obligations and goals. Together, these three approaches make it possible to define preferred offset sites.

The integrated analysis is presented in Figure 10 and combines three maps simultaneously: one of the high-coincidence areas that considers the micro-basins in

the top 80% of the optimized options, the Biodiversity Offsets Regulatory Criteria map, and a third map of the change in economic value associated with restoring each micro-basin. The latter shows that there are areas where restoration produces significant increases in annual economic value — mainly in sectors of the central valley and some transition areas — and, in contrast, those where restoration implies decreases in TEV due to the trade-off with water provision services.

By integrating these three maps, the result is a **portfolio of preferred restoration areas**, which identifies **18,460 ha around the Río Bueno Corridor and the areas near Lake Ranco**, where the three approaches converge spatially. This value represents 1.6 times the area allocated to the basin in the national



restoration target (11,475 ha),<sup>26</sup> showing that within the basin there is flexibility in opportunities to implement strategic restoration that simultaneously addresses environmental, economic, and regulatory priorities.

The areas of overlap are mainly distributed in sectors with moderate slopes and in landscapes dominated by secondary vegetation, agricultural mosaics, and areas of transition to native forest. These landscapes have three simultaneous attributes:

- **high ecosystem benefits** (sediment and phosphorus retention, carbon sequestration),
- **high regulatory priority** due to their contribution

to connectivity or their ecological uniqueness,

- **positive economic changes** that make restoration viable as an intervention.

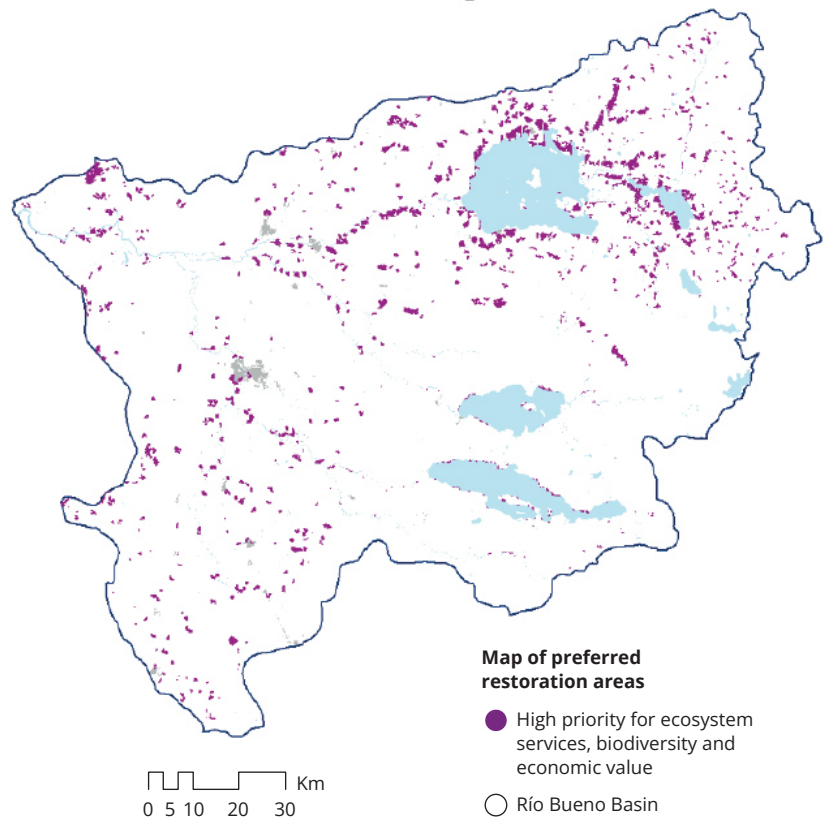
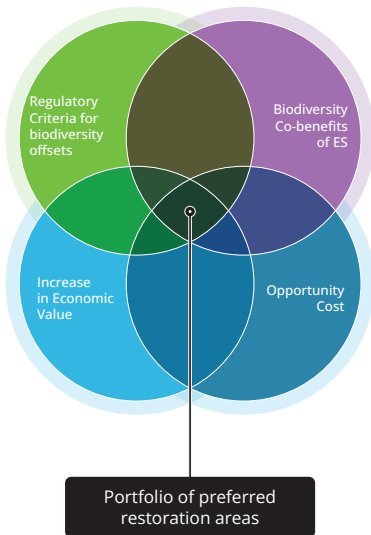
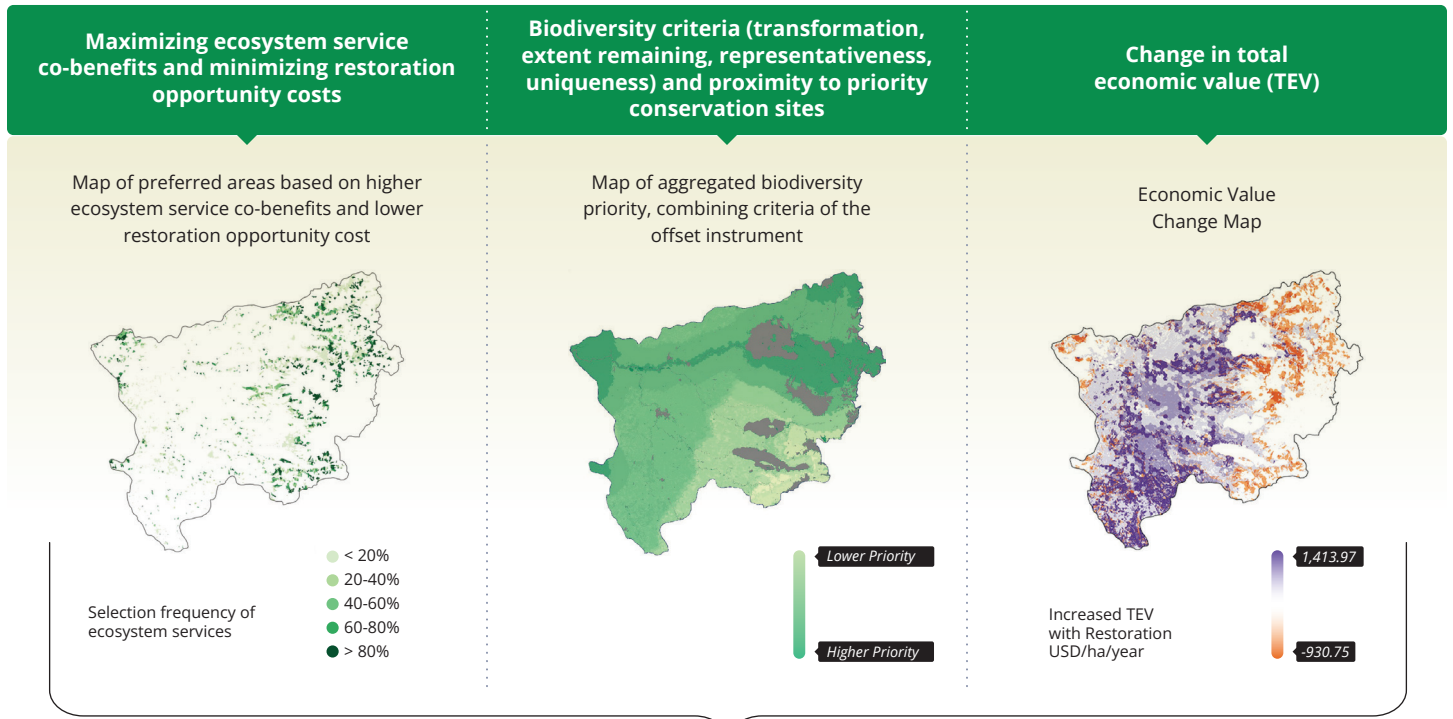
Taken together, this integration reveals a limited but significant set of targets, where restoration represents an opportunity for the practical implementation of environmental, climate, and biodiversity agendas. The identified areas can serve as initial locations for planning pilot projects, guiding ecological restoration programs, or focusing offset measures within the framework of current regulations.

### Box 5

This project is a concrete example of progress towards policy coherence for sustainable development. By integrating nature's current and potential contributions to water and climate agendas, and to biodiversity objectives, through spatial valuation and optimization tools, it promotes cross-sectoral alignment, and guides efficient decisions that maximize ecosystem co-benefits and reduce trade-offs, positioning natural capital as a strategic asset and aligning public and private decisions with Law No. 21,600, the 30x30 Target, and the NDCs. By directing investments towards cost-efficient areas, and identifying key assets of current natural capital, the incorporation of NCA also contributes to strengthening competitiveness and economic stability.

<sup>26</sup> The National Plan for Landscape Scale Restoration in Chile and the Long-Term Climate Strategy (2021), indicates that it will incorporate 1,500,000 hectares of landscapes into restoration processes by 2030, prioritizing those with greater social, economic, and environmental vulnerability. To estimate the proportion corresponding to the Río Bueno basin, an estimate was made based on the relationship between its surface area and the national area, which resulted in 11,475 hectares.

Figure 10. Portfolio of preferred restoration areas.





# Capacity Development

The project has contributed to strengthening technical and institutional capacities to apply the NCA in public management. Through collaborative work, practical training, and exchange between institutions, progress has been made in adopting the approach and in the creation of a common technical basis that supports its future implementation. From the beginning, the Natural Capital Alliance (NatCap) of Stanford University worked together with the Natural Capital Committee (NCC) and national teams on the methodological refinement and training in the InVEST and ROOT (optimization) models, strengthening local competencies in biophysical modeling, economic valuation, and spatial prioritization. This joint work has built a foundation that can be replicated in other regions and help expand technical capacity to integrate the NCA into public policies. At the regional level, the workshops held in Valdivia and Puerto Montt ('Natural Capital and Biodiversity: Exploring Tools for the Implementation of the Biodiversity Offsets Instrument') made it possible to identify information gaps, strengthen inter-institutional coordination, and disseminate the NCA as a practical tool to improve the traceability and effectiveness of biodiversity offsets at the basin scale. In addition, two workshops were held in Santiago with complementary objectives:

**Workshop with the public sector** – 'Progress and Perspectives towards an Integrated Public Agenda for Natural Capital' brought together representatives of more than ten ministries and public agencies (Ministry of the Environment, Ministry of Finance, Ministry of Economy, Development and Tourism, Ministry of Agriculture, Ministry of Energy, Ministry of Housing and Urban Planning, Central Bank, CORFO, among others), allowing aligning priorities and strengthening intersectoral coherence in the incorporation of the NCA in policies, plans, and management instruments.

**Workshop with academia** – 'Applied Research and Public Policy: Advancing the Valuation of Natural Capital' brought together academics and researchers to promote the link between applied research and decision-making, exploring cases, methodologies, and opportunities for collaboration.

In addition, two virtual trainings (webinars) were held to strengthen specific technical capacities:

**Economic valuation of natural capital:** methodological framework of economic valuation, with an example applied to the Río Bueno basin.

**Spatial modeling and integrated applications:** modeling the supply and demand of ES, economic valuation map, spatialization of regulatory criteria, and spatial optimization processes applied to the project.

These actions have laid the foundations for moving toward a community of practice around natural capital, bringing together technical teams, researchers, and decision-makers in a continuous process of learning and exchange around the approach.

Figure 11. Workshops with the public sector and academia, Santiago.



Photo credit: Paula Fournies

## Opportunities for Integration in Public Policies

The technical information generated through the project was also analyzed from the perspective of specific use cases in public policy instruments. These integration opportunities are evaluated at three complementary levels illustrated in the methodological components of the project (Figure 2), with emphasis on the Law for Nature (Law No. 21,600 of 2023):

**i) Level 1:** Applications of information on natural capital as an input for the Biodiversity Offsets Instrument;

**ii) Level 2:** Opportunities for cross-cutting application to other instruments associated with the SBAP (Biodiversity and ES Certification System, ES Remuneration, Ecological Planning); and

**iii) Level 3:** Alignment with other sectoral public policy instruments.

The analysis is generally based on the valuation principle of ES, which is one of the basic criteria for conservation and restoration decisions defined in the Law for Nature.

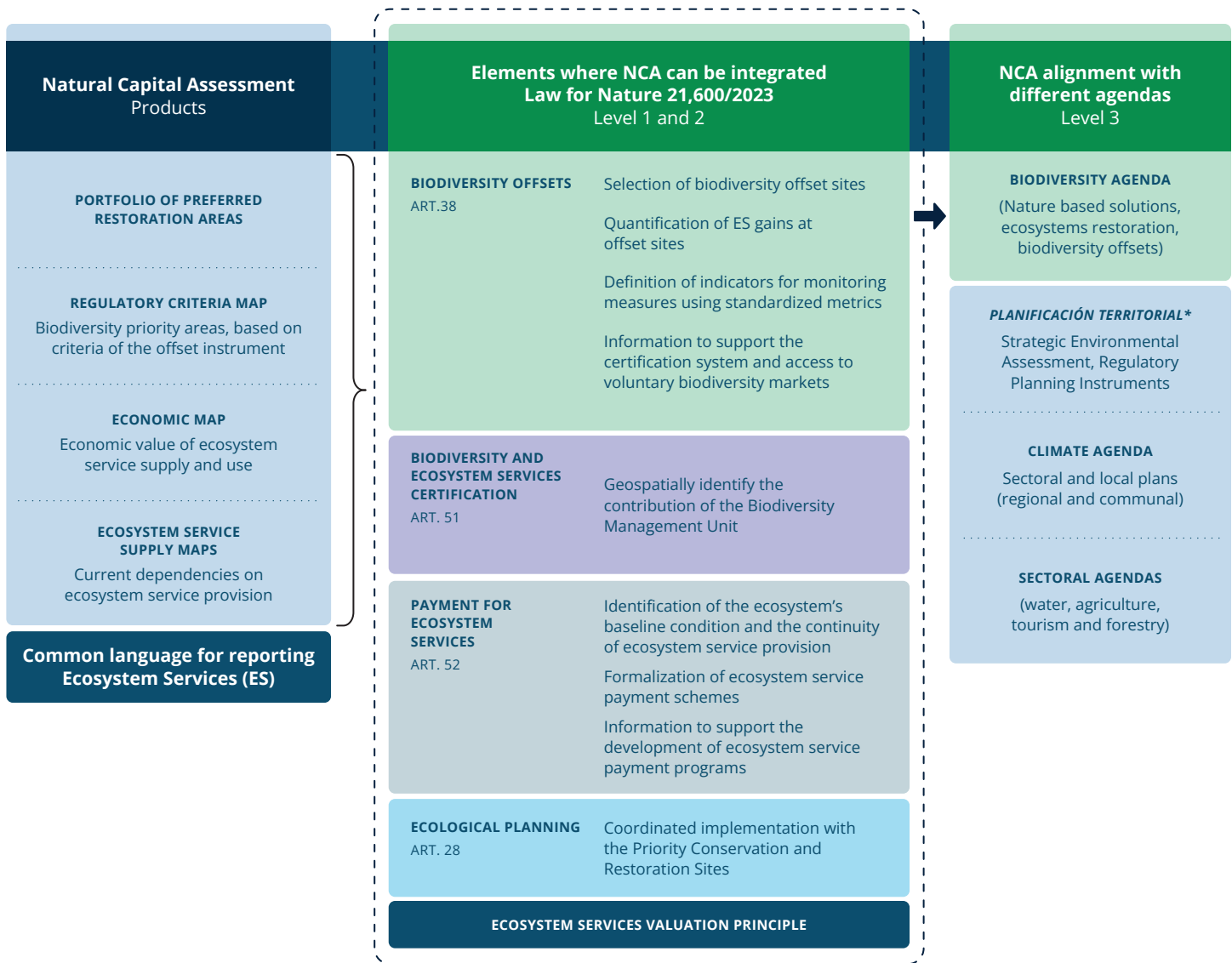


**Figure 12.** Workshops held in the regions of Los Ríos and Los Lagos, with the participation of public entities responsible for implementing policies associated with natural capital.



Photo credit: Xaviera De la Vega.

Figure 13. Opportunities for NCA integration at the different levels and policies analyzed.



\* Refers to an integrated, place-based approach to planning at the local level. It goes beyond land-use planning to include landscape-level considerations and the coordination of multiple sectoral policies within a defined geographic area.

### Level 1 – Inputs for the Biodiversity Offsets Instrument

The Biodiversity Offsets Instrument is explicitly inserted in the conservation hierarchy (avoid–minimize–offset), where compensating operates as a last measure to address residual impacts on biodiversity associated with the development of a project. Its objective is to achieve net gains in biodiversity that are measurable, additional, and lasting, which implies defining where and how to implement measures that are ecologically equivalent

or strategically superior, and that are maintained in the long term. In this context, one of the critical challenges for its operation is the identification of suitable areas for offsets, while simultaneously considering ecological feasibility and institutional and governance conditions.

To help address this challenge, the analysis of the instrument was organized around three central elements: (i) the review of the objectives and requirements of the regulation, including ensuring zero net loss, defining preferential sites for restoration and conservation, and ensuring functional, additional,



permanent, and coherent compensations with other instruments of the SBAP; (ii) the identification of the key questions that the SBAP must answer in order to implement the instrument with spatially explicit information; and (iii) the evaluation of how the evidence generated by the project – through spatial, biophysical, and economic information – helps provide answers to these questions and generates

analyses and information that support the selection of sites and strengthen the traceability of decisions.

Below is a table itemizing the elements of the instrument, based on the regulation, identifying opportunities for NCA integration (mentioned in Figure 14) and explaining the possible use that can be made of the information generated by the project.

**Table 4.** Opportunity for NCA integration and possible use of the information in the Biodiversity Offsets Instrument.

Integration element	Opportunity identified	Use of Information
Selection of compensation sites	Enable the integration of site selection criteria defined in the regulation (legal tool to ensure Differentiated Territorial Application) with other criteria related to the NCA to guide the selection of compensation sites based on different co-benefits.	It allows the generation of key information to <b>guide the selection, justification and monitoring of clearing sites</b> .
Functional Loss and Measurable Goals	To move from offsets based on affected area to one that measures functional equivalence and net biodiversity gain.	It allows <b>quantifying gains</b> in compensation sites for key components of biodiversity (ES), with traceable goals.
Deadlines and durability	To strengthen the temporal traceability of offset measures and their ecological permanence over time.	Establish <b>monitoring indicators</b> that allow monitoring the effectiveness and durability of the measures, supporting their verification by the SBAP.
Voluntary market opening	The Certification System (Art. 51 Law No. 21,600) opens a market for the Voluntary Environmental Commitments (VEC) of SEIA projects, promoting offset and restoration schemes, through the Biodiversity Management Units (BMU), beyond regulatory obligations, including offset sites.	Delivers <b>standardized, traceable metrics</b> related to potential ES beneficiaries that serve the Certification System and voluntary biodiversity markets.

NCA brings transparency, technical coherence, and durability to the offset process, and lays the groundwork for the development of methodological guides and national standards to facilitate its implementation by SBAP and other public institutions. In addition, **the application of the approach within Law No. 21,600 offers an opportunity to strengthen institutional coherence** between the different instruments of the Biodiversity and Protected Areas Service (SBAP), under the same ecological, economic and spatial framework.

## Level 2 – Cross-cutting inputs for other instruments of the Law for Nature

Below is a table summarizing the **opportunities for integrating NCA into other Law No. 21,600 instruments** mentioned in Figure 14 and explaining the possible use that can be made of the information generated by the project by each of the instruments.

**Table 5.** Opportunity for integration of the NCA and use of the information in other SBAP instruments.

Instrument (Law No. 21,600)	NCA integration opportunity
Art. 51 – Certification System for Biodiversity and Ecosystem Services (SCBSE)	The creation of the <b>Biodiversity Management Unit</b> (UGB) as a verifiable and durable financial asset (≥ 20 years), is an opportunity for NCA integration. The information generated by the project allows the <b>geospatial identification of the UGB’s contribution to biodiversity conservation.</b>
Art. 28 – Ecological Planning (Priority Sites)	It allows <b>aligning the priority sites defined by the SBAP with the compensation sites (Art. 32)</b> , directing investments towards areas of greater ecological value. The information generated by the project is an input for its coordinated application, integrating criteria of efficiency and spatial coherence in the restoration and conservation of landscapes.
Art. 52 – Contracts for Payment for Ecosystem Services (CRSE)	The information generated helps to identify <b>the basal condition and functional continuity</b> of ecosystems. It links supply (suppliers) and use (beneficiaries) of ES at relevant local scales, facilitating the formalization of payment for ecosystem services. In addition, it helps with background information for the development of ES Payment Programs.

The integration of the NCA within the framework of Law No. 21,600 demonstrates its potential to **provide the SBAP and environmental institutions with technical and management capacities**, through the generation of unified spatial information that strengthens the application of the different instruments. Likewise, the NCA provides a common language that allows the challenges that arise from Law No. 21,600 to be operationalized and to coherently support instruments such as the Biodiversity Information System, the Conservation Landscapes and others associated with the law.

### Level 3 – Articulation and alignment with other agendas

The inventory of public policies carried out in turn allowed us to detect windows of opportunity to integrate NCA into a broad mix of public policies and their instruments in Chile. For example, this mapping made it possible to identify sectoral policies, objectives, and goals that recognize dependencies on natural capital components or services, or that impact their availability or quality. At the strategic level, the NCA is a common element that connects policies and their various instruments. In this context, ES provision and value maps, together with the identification of preferred areas, constitute relevant inputs to connect strategic decisions in these different areas, among the main ones:

- i. Aligning the **biodiversity agenda**, expanding the scope of the Law for Nature, and giving a local perspective to the goals of international commitments, such as the Kunming-Montreal Global Biodiversity Framework.
- ii. **Planificación territorial**, where the NCA provides concrete and actionable inputs for the Strategic Environmental Assessment and for planning instruments such as the Regional Territorial Planning Plan and the intercommunal and communal regulatory plans. Natural capital information makes it possible to strengthen zoning processes and guide land use decisions considering the benefits that ecosystems bring to well-being and the economy.
- iii. In the case of the **climate agenda**, NCAs articulate the role of ecosystem services in mitigation or adaptation policies. As a tool, it aligns co-benefits of nature-based climate solutions and contributes to the regionalization of measures in the Regional Climate Change Action Plans and Sectoral Plans for Mitigation and Adaptation to Climate Change, with national goals such as the Nationally Determined Contributions Final Report and the Long-Term Climate Strategy.



iv. In **sectoral agendas**—such as water, agriculture, tourism, and the forestry sector—the NCA makes visible the value of ecosystems in economic and public investment decisions. By incorporating common indicators and metrics on ecosystem services, the approach contributes to better coordination between sectors and levels of management of national strategies

and international commitments, promoting negotiations between the objectives of conservation, territorial development and social welfare.

To further analyze the opportunities for NCA integration at different levels, review **Technical Annex 2: Analysis of Policy Instruments**.

## Box 6

### **A practical example of evidence-based decisions: integrating natural capital into biodiversity offsets**

This example demonstrates how the integration of ecological, economic, and regulatory information allows for the optimization of offset decisions, more cost-efficient solutions, and prioritizing areas where restoration generates greater environmental and social benefits. The example is based on a hypothetical scenario of an infrastructure investment project that is expected to be installed in the Río Bueno basin and that must enter the Environmental Impact Assessment System through an Environmental Impact Study, for generating adverse impacts on natural resources (art. 11 Law 19.300/1994).

As indicated in the hierarchy of measures within the Biodiversity Offsets regulation, a project, after avoiding, minimizing, and repairing the impacts generated on biodiversity, must offset the residual loss of biodiversity. This requires identifying the key components of biodiversity in structure and composition, and the loss of functions and services, to determine the restoration goal that allows for at least zero net loss<sup>27</sup> or net gain<sup>28</sup> in biodiversity.

For this example, an impacted area of 20 hectares is assumed, with a residual loss corresponding to 100% native forest (temperate Andean deciduous forest). Under the regulation, the SBAP must identify an equivalent offset site that meets the regulatory criteria and ensures measurable and verifiable results.

With this projection of net gain, it is necessary to develop the biodiversity offset plan, and establish the requirements for the site. Along these lines, the SBAP and the responsible services select three possible sites within the basin that meet the established biodiversity goals. The portfolio of preferred restoration sites identified at the basin scale is a key input to guide this decision, as it allows for the coordinated direction of restoration actions to preferred sites for co-benefits.

To illustrate this, it is possible to compare three cases of site selection, shown in the image in Figure 14.

27 Zero Net Loss: Generated when the residual or remaining impact on the affected key components is equivalent to the gain achieved by the compensation measure

28 Net Gain: Obtained when the gain achieved by the compensation measure exceeds the residual impact.

Box 6 continued

Case 1	Case 2	Case 3
Site selected as an area close to the point of impact, but without considering ES criteria generates 12% of relevant co-benefits	Site with intermediate potential provision: Area with the highest relative contribution to ecosystem services. The equivalent provision increases to 50%, with moderate co-benefits.	Optimized Restoration Portfolio Site High Potential Provision: Combines high ES provision, regulatory consistency, and good benefit/cost ratio. Generates 150% ES equivalent provision to offset the same impact.

Based on the results of the modeling of the ES supply and the co-benefit-based restoration portfolio, it is possible to compare the differences between the effects of restoration in terms of the gain or loss of ES provision in each case. Regarding the original total services, the following are lost:

$$\text{Total Impact} = Pe \times S$$

Where  $Pe$  is the level of loss in the provision of ES for each hectare or unit of area impacted, and  $S$  is the total area impacted, in hectares or the unit of measurement that corresponds to the provision indicators. Then, for each sector, its proportional profit potential is recognized in the face of a restoration, when it is done on the same original surface, that is:

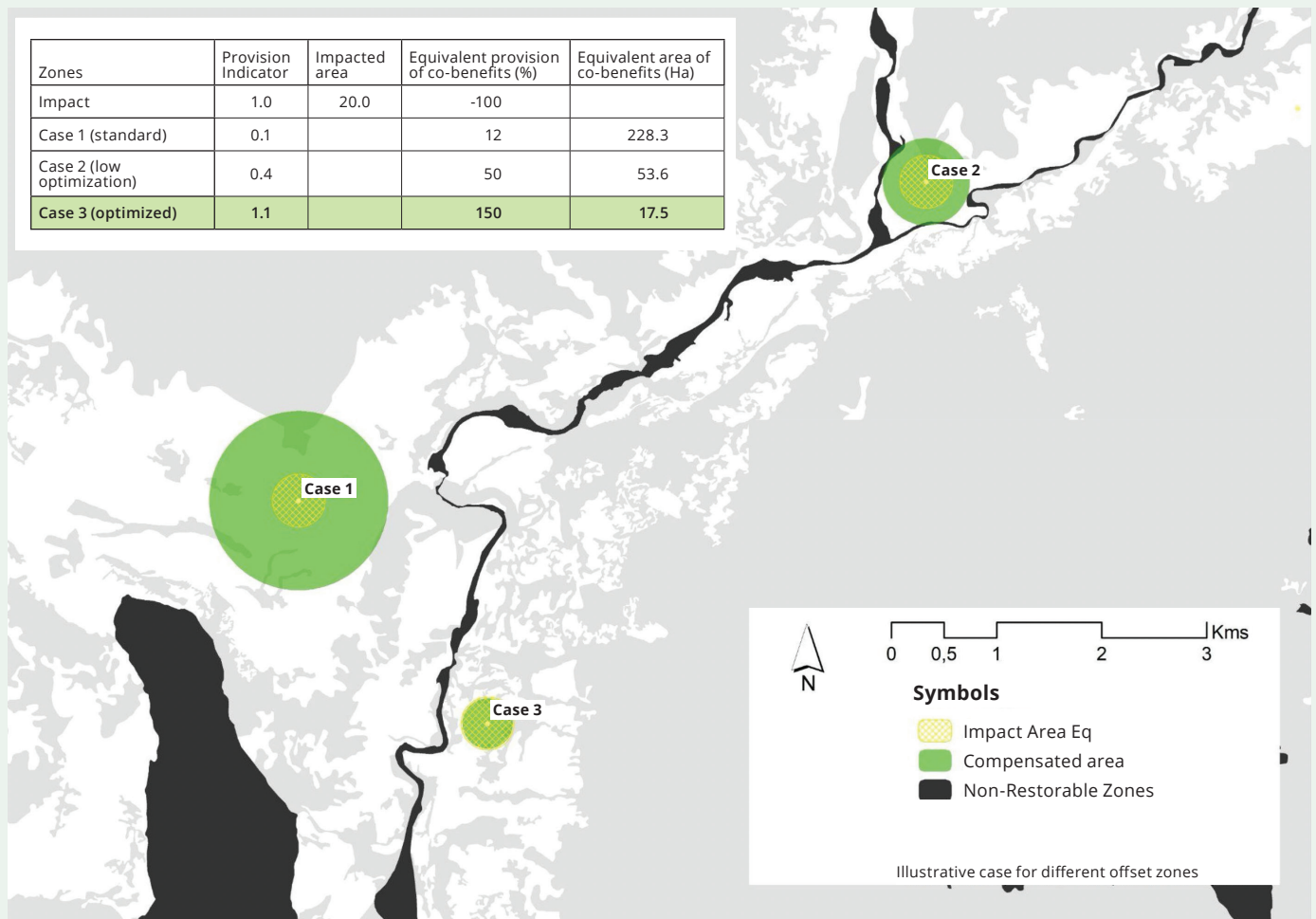
$$\text{Total Profit} = (Gai \times S)/(Pe \times S) = Gai/Pe$$

Where  $Gai$  is the Gain in the provision of ES for each hectare or unit of area of site  $i$ , under a restoration scenario at that site. The Total Profit for each site will be a relative value, interpretable as the percentage of provision reached before the restoration.

The results, illustrated in Figure 14, show the opportunity to generate co-benefits simultaneously in biodiversity and in the provision of ES.



**Figure 14. Possible offset sites for the demonstration example.** Given the differences in the capacity to provide and use ecosystem services in the territory, associated with the types of ecosystems and their spatial and functional characteristics, different alternative offset sites for the same intervention are illustrated. The areas with yellow hatch represent an equivalent offset in terms of area, while the green shows the area required at each site to compensate for the co-benefits lost in the original intervention, reaching a net loss of ecosystem services equal to zero.



# Implementation Strategy

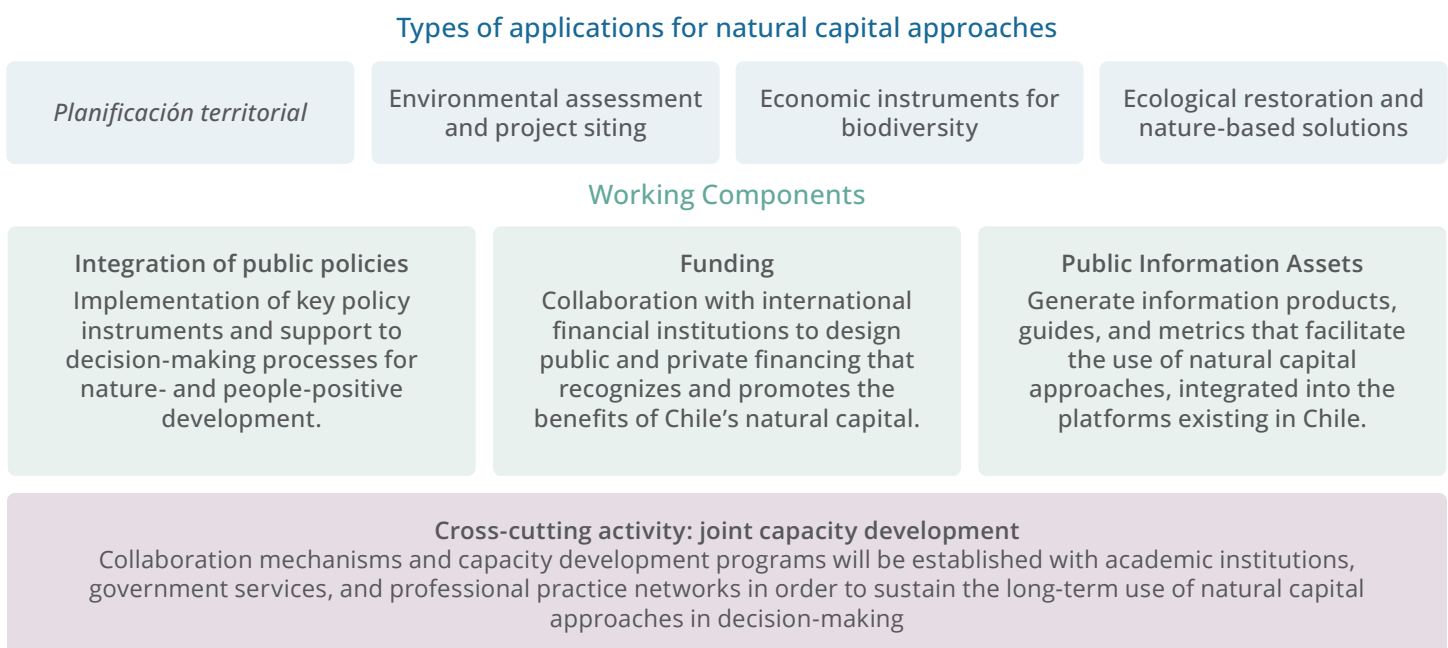
The collaboration between the NCC, Stanford University’s NatCap, and the IDB projected for the next three years (2026 - 2028) seeks to **scale and expand the NCA** in public planning from the experience in the Río Bueno basin, to an application representative of Chile’s diversity.

The work will be expanded to three **macro-zones of the country (north, center, and south)**, hoping to represent the ecological and socioeconomic diversity of

the country, and will seek to **identify where ecosystem services provide greater value to local communities and economies, incorporating this information into sectoral and subnational development policies**, such as ecological planning, environmental assessment, among others.<sup>29</sup>

Figure 15 summarizes the focus of the project for the next 3 years.

**Figure 15.** Focus of the scaling strategy of the natural capital project 2026-2028



Overall, this strategy seeks to expand the progress of the pilot of the Río Bueno basin and project this onto a national scale, promoting a more integrated, transparent, and operational management of natural capital.

The methodological framework developed – which combines biophysical modeling, economic valuation, normative analysis, and institutional integration – is modular and replicable and allows parameters and scales to be adjusted according to the ecological,

socio-economic, and governance particularities of each basin. Its design makes it easy to update individual components, incorporate other ecosystem services, improve local data, or add regulatory layers without redoing the entire study, allowing the approach to evolve iteratively and continue to generate useful evidence to guide policies and cost-efficient decisions.

On this basis, the pilot in the Río Bueno basin provides a **replicable methodological demonstration**, especially for the evaluation and valuation of natural capital,

29 Fact Sheet: [Fostering Nature-Positive Development through the Integration of Natural Capital](#).



and its applications in the application of instruments at the regional level. These components — the logic of the models, the procedures and the analytical framework — can be applied in other macro-areas while maintaining national methodological coherence.

What **requires adaptation** are the inputs that feed these methodologies: the selection of relevant ecosystem services in each territory, the availability and resolution of biophysical and socioeconomic data, the definition of parameters to build optimized portfolios and the **spatialization of the analysis of the prioritized public policy instruments**, whose criteria vary between regulations, such as the PROT, the SEIA or the SBAP instruments.

Scaling should also consider **costs and institutional capacities**, combining the reuse of developed models with targeted investments to address information gaps and strengthen the operational capacities of national and regional public agencies. In this way, the 2026–2028 project will move towards more cost-efficient,

operable, and interoperable versions with institutional platforms, suitable for replication in multiple regions. In the future, the approach can be further strengthened, incorporating new types of services—including cultural and local ones. This could move towards analyses that combine basin scales with finer assessments at the property level, informed by other strategic or sectoral objectives at national scales, integrating temporal dynamics and climate change scenarios, and using methods that better represent synergies and co-production between ecosystem services. In addition, hydrological models can be complemented with more detailed assessments of nonlinear effects, and the estimation of marginal benefits in optimization processes can be improved. These considerations will increase the accuracy, robustness, and applicability of the approach in new territories and policies. Further details on these technical considerations are presented in **Technical Annex 1: Economic and Spatial Dimensions**.

## Lessons Learned and Recommendations

The pilot project in the Río Bueno basin is a pioneering and illustrative application of natural capital approaches for strengthening local development planning, improving the coherence of public policies, and making visible both economic and societal dependence on nature. Within the framework of the project, the biodiversity offsets system was evaluated with respect to the technical information (biophysical, economic, and spatial) necessary to provide useful and applicable evidence for the public agencies in charge of implementing the instrument. This also helped **ensure the information generated by the pilot is relevant,**

**traceable, and operational** within the environmental assessment procedures and biodiversity offset mechanisms.

The lessons learned—complemented by the findings of the national workshops—guide concrete recommendations to move towards a more integrated, coordinated, and evidence-based management of natural capital. **Technical Annex 1 on economic and spatial dimensions** and **Technical Annex 2 on analysis of policy instruments** contain more specific recommendations.

**Table 7.** Summary of the main lessons and recommendations of the project

Key lesson	Associated recommendation
<p><b>Importance of integrating economic, ecological, and institutional dimensions</b></p> <p>The process integrated previously separate dimensions – ecology, economy, and public management – showing that transdisciplinarity in the integration of the approach is essential to generate results and evidence applicable to complex contexts.</p>	<p>Promote interdisciplinary work teams that articulate ecological science, environmental economics, and public management, ensuring that analyses and models are designed from a comprehensive perspective.</p>
<p><b>Need to operationalize the approach</b></p> <p>One of the main challenges is to put NCA into practice, transforming the technical results into instruments and criteria that guide concrete actions in the territory (for example, where to restore, compensate, or invest).</p>	<p>Develop operational guides and protocols that directly link NCA results with practical, place-based decision-making related to prioritization of investments and design of offset measures.</p>
<p><b>Scales and timing of analysis</b></p> <p>The scale of work influences the interpretation of results; analyses should consider the spatial and temporal variability of ecosystem services.</p>	<p>Define from the design of the projects the spatial scales and time horizons most appropriate for the goals of a specific policy, considering ecological and socioeconomic heterogeneity, ensuring coherence with the instrument.</p>
<p><b>Inter-institutional coordination and governance</b></p> <p>The implementation of NCA requires coherence and coordination between management levels (local, regional, national) and between the instruments of the SEIA, the Law for Nature and the sectoral agendas. A gap persists between the ecological scale (basins) and the administrative scale (regions and communes).</p>	<p>Strengthen and formalize inter-institutional coordination (SMA–SEA–SBAP) at different levels. Consolidate the NCC as a connector between the different sectors.</p>
<p><b>Quality, consistency and standardization of information</b></p> <p>The accuracy of the results depends on the quality of the data and the transparency of the economic and spatial assumptions. Environmental information is dispersed and heterogeneous, with a lack of georeferencing, periodicity, and data on the use and beneficiaries of ecosystem services.</p>	<p>Develop common protocols on data standards, traceability, and sensitivity analysis. Move towards an interoperable national system that includes information on natural capital with integrated data.</p>
<p><b>Common guides and metrics</b></p> <p>The SBAP is responsible for leading the development of standardized metrics and guides to quantify residual impacts and biodiversity gains at the micro-watershed and farm level (soil, vegetation).</p>	<p>Advance in the development of guidelines and protocols for monitoring and verification of offset plans, highlighting marine and coastal ecosystems that do not yet have guidelines for impact assessment or offset measures.</p>



Key lesson	Associated recommendation
<p><b>Integration of economic instruments and resource efficiency</b> Economic value maps, aligned with ecological and regulatory information, facilitate the orientation of investments and prioritization of cost-efficient areas for restoration or compensation.</p>	<p>Incorporate natural capital into financial and budgetary instruments, promoting green incentives, cost-effective offset mechanisms, and restoration schemes.</p>
<p><b>Technical capacities and continuous learning</b> The joint work between NatCap, the NCC and national institutions has contributed to strengthening competencies in modeling, assessment, and appropriation of the approach. The process evidenced the need for continuous learning and iterative validation to sustain the approach over time.</p>	<p>Consolidate training programs and technical support for continuous learning. Establish a national community of practice that maintains collaboration between actors, updates methodologies, and accompanies the process of scaling up NCA, establishing permanent collaboration mechanisms between scientific teams with the NCC. Promote a national network of applied research.</p>
<p><b>Communication and social appropriation of the approach</b> Making visible the value of nature and its relationship with well-being generates legitimacy and favors the adoption of NCA in public management.</p>	<p>Develop a communication and education strategy that highlights the practical usefulness of integrating the approach into specific policies.</p>
<p><b>Modularity of NCA</b> For various components of natural capital, Chile already has an information base, and solid institutional and scientific capacity to characterize ecosystems and their services in a systematic manner and at relevant scales for decision-making. There are also components on which it is necessary to develop lines of research and monitoring.</p>	<p>Implement a modular roadmap, with medium- and long-term programs to expand the evaluation and valuation of ecosystem services, and the perceived benefits in the economy and human activity.</p>

The pilot project in the Río Bueno basin demonstrates that the application of NCA allows the integration of biophysical, economic, spatial, and regulatory information in a coherent and operational way, generating and synthesizing technical evidence in a practical tool for public decision-making. The products developed make it possible to compare alternatives, prioritize interventions, and guide management actions that connect public and private frameworks, facilitating the implementation of public policy instruments – such as biodiversity offsets – in a more transparent, cost-efficient and evidence-based way.

In practice, this approach helps to define where to focus restoration efforts, guide public and

private investments, and technically support complex decisions, reducing opportunity costs and strengthening coherence between environmental, economic, and social objectives. Beyond the specific results of the pilot project, the methodology developed is replicable and adaptable to other contexts, offering a solid basis for scaling up the integration of natural capital in planning, investment, and public management at the national level, and moving towards more sustainable, resilient development aligned with the well-being of people and nature.

Read more and access the appendices to the report on this project page here: <http://bit.ly/3PsChile>.



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