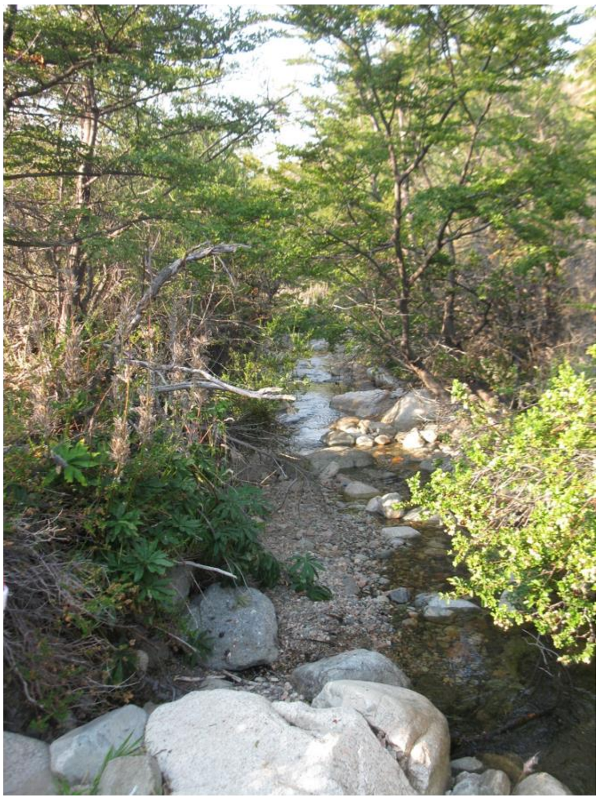
Pilot Project: Integrating data into sector-wide decision making to improve the protection and restoration of freshwater ecosystems

Esquel-Percy System Action Plan



Argentina, 2022

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Acronyms

APN. Administración de Parques Nacionales *[National Parks Administration]*

Cap-Net. International Capacity Development Network for Sustainable Water Management

CCRF. Comité de Basin del Río Futaleufú [*Futaleufú River Basin Committee]*

DGByP. Dirección General de Bosques y Parques de la Provincia del *Chubut [General Directorate of Forests and Parks of Chubut Province]*

DNPHyCF. Dirección Nacional de Política Hídrica y Coordinación Federal [*National Directorate of Water Policy and Federal Coordination]*

DNGAAyEA. Dirección Nacional de Gestión Ambiental del Agua y los Ecosistemas Acuáticos *[National Directorate of Environmental Management of Water and Aquatic Ecosystems]*

ENHOSA. Ente Nacional de Obras Hídricas y Saneamiento *[*National *Entity for* Water and Sanitation *Works]*

FEE *6.6.1*. Freshwater Ecosystem Explorer *6.6.1*

FONDAGRO. Fondo Fiduciario Nacional de Agroindustria [*Agroindustry National Trust Fund]*

GLC. Grupo Local de Coordinación *[Local Coordination Group]*

GWP. Global Water Partnership

INDEC. Instituto Nacional de Estadísticas y Censo *[National Institute of Statistics and Census]*

INTA. Instituto Nacional de Tecnología Agropecuaria *[National Institute of Agricultural Technology]*

IPA. Instituto Provincial del Agua *[Provincial Water Institute]*

MAGyP. Ministerio de Agricultura, Ganadería y Pesca de la Nación *[Ministry of Agriculture, Livestock and Fisheries of Argentina]*

MAyCDS. Ministerio de Ambiente y Control de Desarrollo Sustentable *[Ministry of Environment and Control of Sustainable Development]*

MAyDS. Ministerio de Ambiente y Desarrollo Sostenible *[Ministry of Environment and Sustainable Development]*

MDP. Ministerio de Desarrollo Productivo de la Nación *[Ministry of Productive Development of Argentina]*

ODS. Objetivos de Desarrollo Sostenible [*Sustainable Development Goals]*

ONU. Organización de la Naciones Unidas *[United Nations]*

PTLC. Planta de Tratamiento de Líquidos Cloacales *[Sewage Treatment Plant]*

QBR. Qualitat del Bosc de River banks (Catalan)/ Riparian Forest Quality (English)

RNU. Reserva Natural Urbana *[Urban Natural Reserve]*

SAyDS. Secretaría de Ambiente y Desarrollo Sustentable de la Nación *[Secretariat of the Environment and Sustainable Development of Argentina]*

SIyPH. Secretaría de Infraestructura y Política Hídrica *[Secretariat of Infrastructure and Water Policy]*

SMN. Servicio Meteorológico Nacional *[National Weather Service]*

SNIH. Sistema Nacional de Información Hídrica *[National Water Resources Information System]*

SSRH. Subsecretaría de Recursos Hídricos de la Nación *[Subsecretariat of Water Resources of Argentina]*

UFC. Unidad Formadora de Colonias *[CFU: Colony-forming Unit]*

UNEP-DHI. United Nations Environment Programme-DHI Centre

MBGI. Manejo de Bosque con Ganadería Integrada *[Promotion of Forest Management with Integrated Livestock Plans]*

WHO. World Health Organization

1. Introduction

The Pilot Project *Integrating freshwater data into sector-wide decision making to improve the protection and restoration of freshwater ecosystems* is being developed simultaneously in Argentina, Kazakhstan and Kenya, implemented by GWP and Cap-Net, with the support of The United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP), under the direction of the Water and Environment Division (UNEP-DHI).

The *"Formulation of the Esquel-Percy System Action Plan"* is a collaborative work between the Subsecretariat of Environment Management and Sustainable Development, under the MAyCDS of Chubut and the Provincial Water Institute, acting as Provincial Coordinators, along with the contribution and commitment of 20 institutions and organizations associated with the basin's subject matter.

In Argentina, this initiative is coordinated by FAdA (Argentine Water Forum, GWP Argentina) and Arg Cap-Net [Argentine Capacity Development Network for Training and Strengthening in Water Resources Management], together with the National Directorate of Environmental Management of Water and Aquatic Systems which, as an SDG 6.6.1 Focal Point, counts with the collaboration of the National Directorate of Federal Coordination and Water Policy, as a strategic partner.

On the following pages we can clearly see that the above-described basin is an area with enormous challenges since it suffers multiple pressures related to demographic expansion, livestock exploitation with low-technology adopted, and development of real estate and tourism, along with climate change effects.

Argentina subscribed to 2030 Agenda, committing itself to its implementation and the establishment of a process for systematic monitoring and progress analysis to achieve sustainable development goals. The actions proposed in this plan are especially oriented towards the achievement of SDG 6.6 which seeks to protect and restore inland aquatic ecosystems for sustainable development and climate resilience.

2. Initial Analysis

2.1. Biogeographical context

The Esquel-Percy System is part of the Subbasin of the same name being located in the northwestern sector of the province of Chubut (Figure 1), in the Futaleufú department. This system is part of the 7,345 km^2 Futaleufú (Argentina) - Yelcho (Chile) binational basin which flows into the Pacific Ocean (SSRH, 2002). The Subbasin is delimited by parallels 42°37' and 43°17' South Latitude and meridians 71°15'and 70°54' West Longitude; and occupies an area of 2,447 km^2 distributed mainly in North-South direction.

Climatically, this region has been classified as temperate-cold (Paruelo et al. 1998), with a mean annual temperature of 7°C, and winter mean temperatures ranging between 1°C and 3°C; and in summer ranging between 14°C and 16°C, showing a marked seasonality throughout the year. Precipitation mainly takes place from May to October, with snowfalls in winter (June to September). Summers are dry and warm. The streams typically present two annual peak flows: one in autumn due to precipitation, and the other one in spring due to meltwater (Coronato & Del Valle 1988).

Vegetation patterns mainly vary as a result of rainfall, which ranges from 1,200 mm per year in the western border of the basin to 530 mm in the eastern sector (SMN, Esquel Airport Station), this marked decrease takes place in only 50 km in a west-east direction. The volcanic soils are rich in organic matter sustaining a valuable biodiversity representative of the temperate forests of South America.

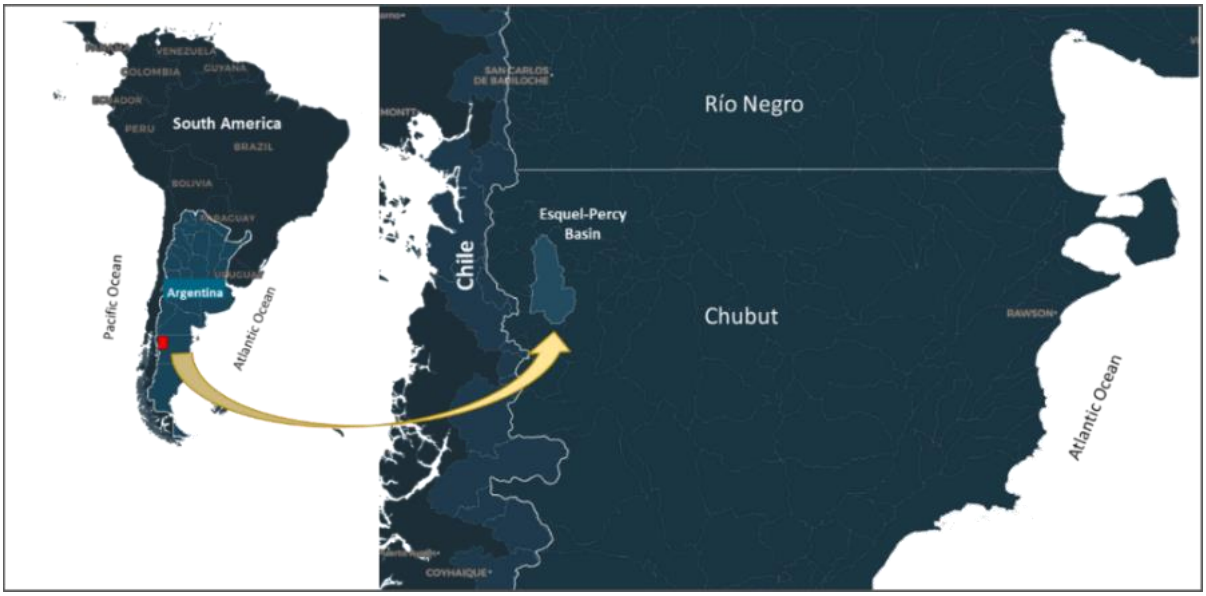


Figure 1. Geographical location of the Esquel-Percy System in the northwestern sector of the province of Chubut, Argentina

Phytogeographically, the basin contains elements of the Antarctic and Neotropical Regions. Within the former, we find the westernmost sector of the area that corresponds to the Temperate Deciduous Forest District, (Subantarctic Domain - Subantarctic Province) characterized by species of *Nothofagus* genus. The Neotropical Region is represented in the easternmost sector of the basin (Patagonian Province, Western District) by the ecotone between the sub-Antarctic Forest and the Patagonian steppe, characterized by species such as *Nothofagus antarctica*, *Maytenus boaria* and *Lomatia hirsuta* (Cabrera & Willink 1980) (Figure 2).

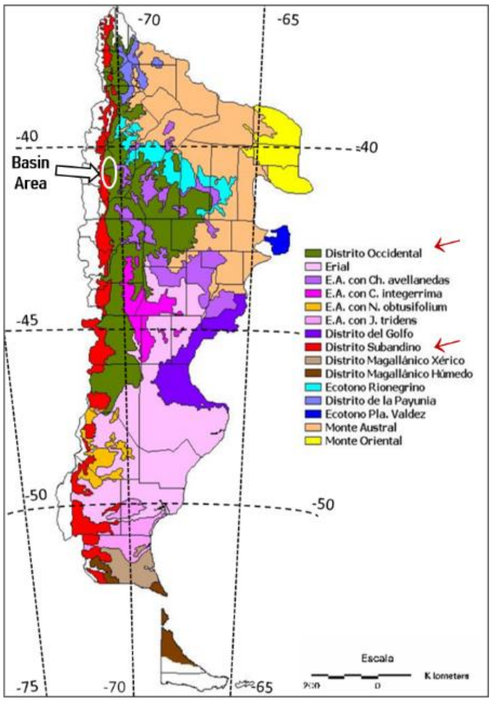


Figure 2. Large vegetation units of Patagonia Argentina (Source: León et al. 1998)

The Percy River, classified as a permanent fifth-order watercourse, has an average flow of 12 m^3/s (National Water Information System). It originates between the foothills of Cordón Leleque and the western slope of Cordón Esquel. In its almost 80 km course, Percy River receives the contribution of numerous low-order tributaries, including the Esquel Stream. Once it receives this contribution, it crosses the 16 de Octubre Valley and the town of Trevelin, before joining the Corintos River at a height of 350 m. The Corintos River has its headwater at the southeastern limit of the Subbasin between Loma Grasa and Cordón Esquel, southeast of the 16 de Octubre Valley (SSRH 2002) (Figure 3, enlarged in appendix).

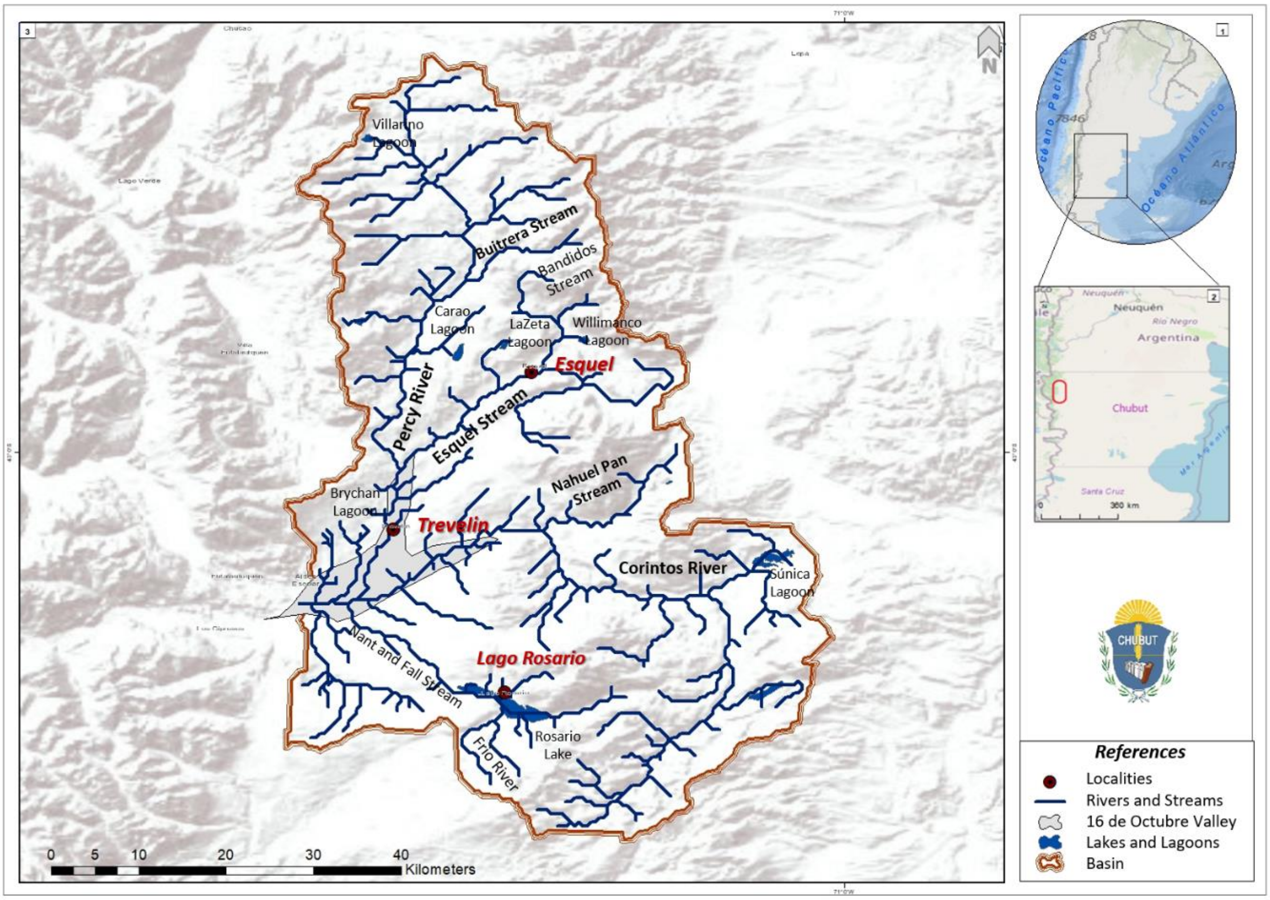


Figure 3. Hydrological system of the Esquel-Percy Subbasin and its hydrological system. *(*Source: *IPA)*

The Esquel Stream is a third-order watercourse with an average flow of 1.33 m^3/s (National Water Information System) and originates at an altitude of 1,500 m on the southeastern flank of Cordón Esquel. It descends through canyons, crosses the city of Esquel receiving the contribution of the Valle Chico Stream continuing its course through a large valley until it joins the Percy River.

The Subbasin does not have large lakes, but it does have numerous shallow bodies of water (proglacial lakes), mostly moraine-dammed lakes or confined to the depressions of the plains formed by glacial sediments, among which we can mention Willimanco, Carao, La Zeta, Brychan lagoons and Rosario Lake. The region has a large number of Patagonian wetlands, colloquially known as "mallines", of various sizes fed by surface water, waters from subalveous and springs, with vegetation made up of grass prairies, Juncaceae and Cyperaceae.

2.2. Legal and institutional framework

The Argentine Nation is a federal country where Provincial States retain their autonomy in spite of being united under a common government. As a result, there are different regulatory levels which, in specific cases, show certain inconsistencies or areas that are yet to be defined and which need to be remedied.

In this sense, Article 124 of the National Constitution establishes that Argentina's provinces are responsible for natural resources and the management of water and environmental resources within their territory.

The fundamental national laws on this matter are:

- The Civil and Commercial Code (2015) establishes that watercourses, navigable lakes and lagoons, glaciers and periglacial environment, groundwater and any other water that has or acquires the aptitude to satisfy uses of general interest, are goods of public domain
- The General Environmental Law (Nr. 25,675) establishes the minimum standards of the National Environmental Policy with the purpose of achieving development through a sustainable and adequate management of natural resources, as well as the preservation and protection of biodiversity
- Environmental Water Management Regime Law (Nr. 25,688), which establishes the minimum environmental standards for the preservation of water, its exploitation and rational use[1].
- The National Glaciers Law (Nr. 26,639) defines a Minimum Standards Regime for the Preservation of Glaciers and the Periglacial Environment, with the main objective of preserving these strategic reserves of water resources and creating a National Glaciers' Inventory, thus recording all the necessary information for their adequate protection, control and monitoring.

Currently, several Bills on Minimum Standards for environmental protection and sustainable use of wetlands are being discussed in the National Congress. In 2021 the MAyDS created the "Wetlands' Program" (Resolution 80/21) that seeks to boost the conservation and sustainable use of wetlands, as well as to ensure the maintenance of the ecosystem services they provide, and promote the development of adequate information tools for management, as the National Wetlands Inventory. Its key element is the interjurisdictional articulation with provincial authorities, as a basis for the federal formulation of policies on the aforementioned ecosystems.

Argentina has adhered to several international agreements related to the conservation of aquatic ecosystems, as follows:

- Ramsar Convention (1971), approved in Argentina by Laws Nr. 23,919 and Nr. 25,335
- Convention on Biological Diversity (1992), approved by Law Nr. 24,375
- United Nations Framework Convention on Climate Change (1994) approved by Law Nr. 24,2945; it formulates the Law on Minimum Standards for Adaptation and Mitigation of Global Climate Change (Nr. 27,520) and its regulatory decree.

In addition, Argentina has Water Policy Guiding Principles agreed upon by all the Provinces and the Nation, adopted by the Federal Water Agreement and which gave rise to the Federal Water Council (COHIFE).

At the provincial level, Article 109 of the Constitution of Chubut establishes the right to a healthy environment ensuring human dignity and well-being, and the duty to preserve the healthy environment in pursuit of the common interest. Thus, Chubut enacted the Environmental Code of the Province (Law XI Nr.

[1] The regulation of the environmental water management law has not been issued.

35), whose purpose is the preservation, conservation, defense and improvement of the environment of the Province of Chubut. This Code mentions the use, management and protection of water and aquatic ecosystems. Likewise, with the purpose of coordinating Projects and Programs related to Climate Change in the Province of Chubut, the Provincial Climate Change Program was created in 2020.

In the same year, Decree 692/20 was signed, and the Provincial Board of Sustainable Development Objectives was created.

Also, the province has a Water Code (Law XVII Nr. 53) which establishes that the water regime in its jurisdiction will be governed by rules and regulations of the Civil and Commercial Code, and that the State will promote whatever is necessary for the study, administration, use, control, conservation and preservation of water resources in the provincial territory. Among the main regulatory norms are Decree Nr. 1540/16 which establishes the new guide levels for emission sources and discharges, and Decrees 185/09 and 1003/16 which establish the procedures for the Environmental Impact Studies.

Consistent with its legal framework, the institutional framework includes governmental organizations at national, provincial, county and municipal levels. Two of the organizations at the national level are the DNGAyEA and the DNCFyPH, under the authority of MAyDS and SIyPH respectively. At the provincial level, the Provincial Water Institute (IPA) was created as an autarchic entity responsible for the elaboration and control of the Provincial Water Program, and it is the enforcement authority of the Water Policy Law (Law XVII Nr. 88) and the Water Code as well as of all regulations related to water management.

Also, the Basin Committees were created (Law XVII Nr.74), which are legal entities authorized to act in the fields of public and private law, as instruments of the provincial Water Policy. With regard to this project, the Futaleufú River Basin Committee (CCRF) was created, where Esquel, Trevelin and Cholila municipalities, water resource users, the National Parks Administration (APN), water and energy supply entities, the industrial sector, and Science and Technology university entities are represented. This committee acts as a discussion and negotiation table among the different representatives, promoting agreements and consensus on aspects related to the management of this basin.

The Futalefú River basin does not have an integrated management plan. However, Los Alerces National Park (located in the northwestern sector of the basin) has a management plan that includes its buffer zone.

In addition, it is envisaged the application of the Integrated Water Resources Management (IWRM) that considers all the uses of the region's water resources as a whole, and defines strategies and priorities that ensure the sustainable use of this resource.

On the other hand, the municipalities promote the preservation and valorization of urban aquatic environments through ordinances aimed at protecting and restoring wetlands and watercourses of high socio-environmental value. Thus, in the Esquel-Percy system, four Urban Nature Reserves have been created: Brychan Lagoon, Percy Riverside Coast, Blanco Stream and La Zeta Lagoon.

2.3. Socio economic context

The Subbasin is geographically located in the Futaleufú Department (43,076 inhabitants, i.e. 4.6 inhabitants/km^2) in the northwestern region of Chubut Province. The towns with largest populations are Esquel (32,221 inhabitants) and Trevelin (7,908 inhabitants) (INDEC 2010), with a population growth between 66% and 70% in both localities during the last 30 years. This increase is due to natural population growth, internal migration at the provincial level, from other provinces and regions of the country, and from neighboring countries (INDEC 2010). The two main urbanizations concentrate more than 95% of the Subbasin population, and the remaining 5% gathers in small towns or communities and scattered villages.

This urban expansion has resulted into a greater demand for drinking water, as well as a greater volume of effluents to be treated. In the towns of Esquel and Trevelin at present the population currently consumes around 300 liters of water per inhabitant per day, which exceeds WHO recommendations for human consumption (between 50 and 100 liters/inhabitant/day). On the other hand, these values also exceed ENHOSA recommendations for safe water consumption for metered home connections, which is between 150 to 200 liters/inhabitant per day with a maximum of 250 liters/inhabitant per day, taking into account the semi-arid climate conditions of the basin.

During summer, the consumption has reached 420 liters/inhabitant per day in the city of Esquel. This high demand, added to the change in climate conditions over the last 10 years, generates a shortage of water for consumption during the summer, and a great pressure on the rivers.

The native forest supports two different productive activities: the extraction of timber forest products, especially for firewood purposes, and silvopastoral activity in *Nothofagus antarctica* forests (Guitart 2004), which supports one of the most important and productive activities in Patagonia: cattle breeding and/or mixed sheep-bovine livestock (Manacorda and Bonvissuto, 1997, Hansen et al. 2008, SAyDS, 2005).

Likewise, exotic species are harvested for timber use; there are planted forests in the area, mainly ponderosa pine (*Pinus ponderosa*) and oregon pine (*Pseudotsuga menziesii*), the latter sharing the native forest environment (Second National Inventory of Native Forests 2016).

In the valley close to Percy and Corintos rivers, forages seeding and storage (alfalfa and barley) are produced with an irrigation system that makes up for the scarcity of rainfall. In addition, other agricultural activities are developed such as horticulture, fruit growing and, more recently, wine production, with a growing number of vineyards, some of which provide an ecotourism experience to visitors.

An irrigation system that currently consists of three intakes on the Percy River and a distribution network with an approximate 1,800 hectares reach benefiting about 60 producers was generated in order to systematize and regulate the water demand for production. At the same time, the Molino Andes Irrigation Consortium was created in Trevelin to provide irrigation and drainage services, under a concession granted by the Enforcing Authority (IPA).

There are various tourist attractions in the department of Futaleufú such as Los Alerces National Park, declared a World Heritage Site by UNESCO, La Hoya Ski Resort, the Baguilt Lake and Nant and Fall Waterfalls Protected Natural Areas, and the Old Patagonian Express, a narrow-gauge steam train with 100-year-old locomotives. To meet tourist demands, both localities and areas of influence have cabins, hotel and gastronomic services that increase on a seasonal basis the pressures on the natural environment.

2.4. Pressures on the aquatic ecosystem and its drivers

The population growth in the region, changes in land use and climate change are processes that increase pressures on aquatic environments. Accordingly, the difficulties for the effective control of the water resources use, the lack of full compliance with current regulations, and the need to improve the coordination of interinstitutional work in water resource management increase the effect of the above-mentioned pressures.

The Subbasin has been historically disturbed by anthropic action, as a result of fires, cattle raising, the elimination of woody vegetation cover and urbanization. Populations are continually expanding, which implies an increase in the demand for the provision of services, land for housing or production, and a greater requirement for the treatment of waste and effluents that are generated.

The urban expansion of Esquel and Trevelin during the last 20 years, without an adequate territorial planning, has been one of the determining factors affecting different components of the Subbasin aquatic and terrestrial ecosystems.

The lack of an appropriate land-use planning, the increase in water demand and the growing shortage of this resource, together with an inefficient waste and effluents treatment, have a direct impact on the watercourses that modifies their natural physical and chemical conditions, triggering a cascade of reactions that end up altering the functioning of the ecosystem and, consequently, the goods and services it provides.

On the other hand, the climate changes, with a decrease in mean annual rainfall and an increase in mean temperatures with regard to historical values, especially in the last 10 years (Meteorological File - INTA Trevelin 2022; SMN 2022) aggravate the problem. One of the most worrisome consequences is the change in the hydrological regime that in many cases produces the disconnection of fluvial systems, with a loss of habitat and associated biological communities, as well as a significant decrease in their self-depuration capacity.

At present, the System shows worrying signs of degradation, such as loss of riparian vegetation, alteration of the fluvial channels of tributary rivers and streams, and erosion of the banks and river banks, accompanied by a loss of biodiversity in the watercourses, and a significant increase in sediments (Miserendino et al. 2016; Miserendino et al. 2021). The Patagonian wetlands are also exposed to anthropic use by cattle grazing. This results into loss of soil and water quality, with higher concentrations of nutrients, suspended solids and conductivity (Epele et al. 2018). In the Subbasin, as in a large part of Patagonia, negative impacts of cattle on regeneration and dynamics of the forest (Hobbs 1996) and understory (Revla &Veblen 1998; Raffaele et al. 2011) have been documented. However, this is a standard practice developed by most rural settlers in the mountain and foothill valleys of northwestern Chubut, affecting the ñire (*Nothofagus antarctica*) and lenga (*N. pumilio*) forests and associated Patagonian wetlands. The continuous herbivory of these forests hinders regeneration, favoring the dispersion and invasion of exotic grasses, and increasing the relative abundance and dominance of low palatability species (Quinteros, 2018).

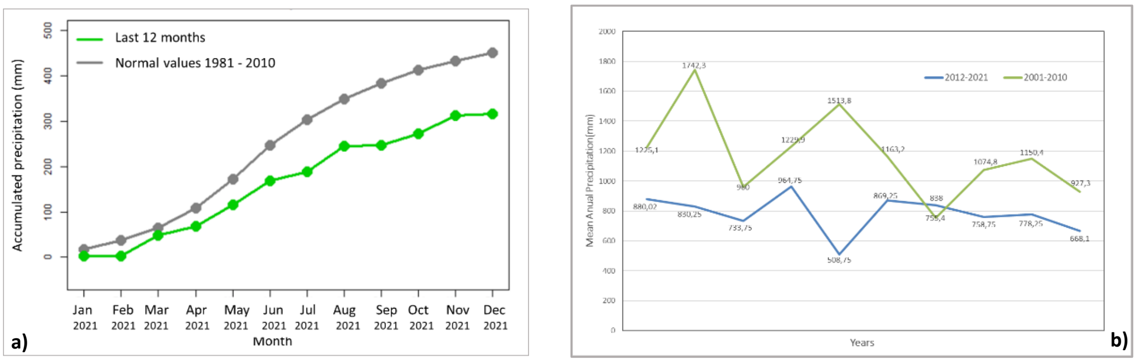
The interaction between freshwater aquatic ecosystems and human societies are drivers of ecosystem changes. To understand the links, the potential direction of change, and how said interaction will affect the state of the ecosystem, a Drivers-Pressures-State-Impact-Response (DPSIR) analysis was used, which is presented in Table 1 in the Annex.

2.5. State of ecosystem

Changes in the extent of freshwater ecosystems

The climatic factors, geological features, vegetation, soil characteristics and land uses influence the hydrological behavior of a basin.

The climate characteristics are showing important changes in the precipitation pattern. Data from the last 20 years show a downward trend in annual mean values (Figures 4 *a* and *b*), going from 960 mm (1998 historical value – up to present in Trevelin) to 783 mm in the last decade (INTA Trevelin Meteorological Archive, 2022). In the case of the city of Esquel, comparing historical data with the last two years, there is an average decrease of 100 mm per year (SMN, Airport Station 2022). The climate change projections for the region estimate that the temperature will increase between 2°C and 2.5°C, while precipitation will decrease between 10 and 20% by the end of the century (Barros & Vera 2014, Pessacg et al. 2020), which will significantly modify the hydrology of the basin. There are no historical snowfall data in the province, therefore it is not possible to know exactly the contribution of meltwater to the aquatic ecosystems of the basin.



**Year 2011, no data available*

Figures 4.a) Comparison between the accumulated curve of mean monthly precipitation values with respect to the curve for year 2021 (Source: *SMN*, *Esquel-Airport Station*). b) Comparison between the last two decades of mean annual precipitation values in Trevelin (Source: Meteorological Archive INTA Trevelin 2022).

The Freshwater Ecosystem Explorer 6.6.1 indicator is a tool that enables us to understand the dynamic changes in the world's aquatic ecosystems (https://map.sdg661.app/). In the basin, data from this indicator were used, which were previously adjusted to the Subbasin scale. The calculations were made using the 2001-2005 average as a reference, and the change was estimated for year 2022.

The results show a total decrease of approximately 1.55 km^2 for the last 20 years in the extent of permanent rivers and lakes in the basin, which represents an 8.14% loss of these ecosystems. Instead, there is a 0.5% increase in the extent of seasonal waters. Between the years 2011-2015, the loss of extension is more abrupt compared to reference years (11.6%), with a slight recovery in the following five-year period (3.67%) (Figure 5*a*). Analyzing these transitions, a relation is observed between the years with permanent waters loss compared to other years with an increase in seasonal water (Figure 5*b*), suggesting that the distribution of water varies in an inverse proportion depending on the year and the climatic conditions and use in the region.

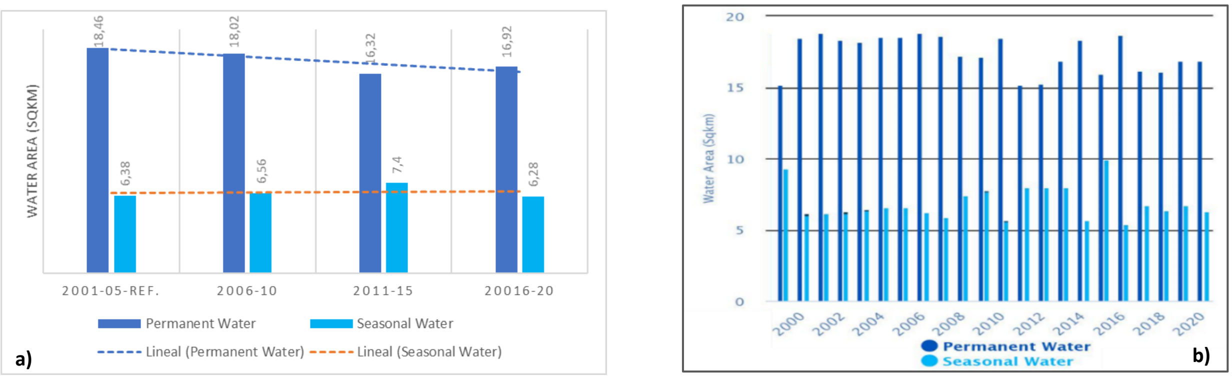


Figure 5. Changes in the extent of permanent and seasonal waters of the Subbasin **a)** by five-year period *Source: Own elaboration* and b) by years (*Source: FEE 6.6.1. 2022).*

The graphs in Figures 6*a* and *b* show the extent to which the dynamics of permanent and seasonal surface waters have undergone transitions between different states. Figure 6*a* shows that 9.4% of the surface waters have gone from a permanent to a seasonal regime state, while 1.1% represent changes in which the loss has been permanent (i.e., an area that has gone from water to land). Figure 6*b* shows the loss of 27.5% of existing seasonal water courses and the gain of 10.9% of new seasonal water courses, consistent with the percentages of permanent-seasonal transition.

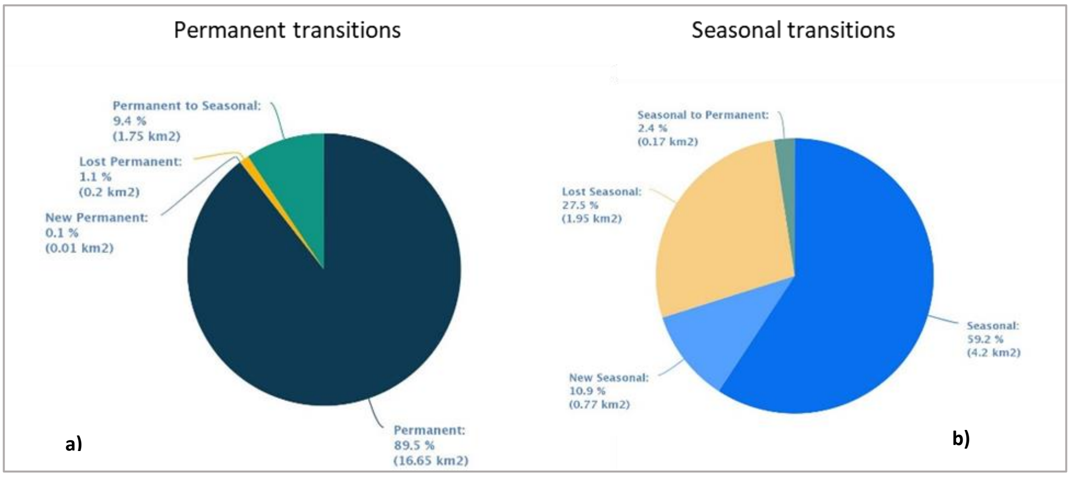


Figure 6. Relative percentages of permanent (a) and seasonal (b) transition types for the aquatic ecosystems of the basin (Source: FEE 6.6.1. 2022)

The area occupied by wetlands in the basin is of 1.37 km^2, approximately (FEE 6.6.1). Although these data could be underestimated since they have not been validated in the field yet, they would allow us to monitor the general trend. The map shows that a part of the losses is related to the basin lagoons such as L. Carao and L. Willimanco, the latter being a reservoir that partly supplies safe water to the city. Likewise, in all water bodies there is a transition trend from permanent to seasonal water in certain sectors (Figure 7).

The comparison of rivers' level data (SNIH 2022; Futaleufú Hydroelectric Power Plant 2022) confirms a downward trend in the extent of aquatic ecosystems. The mean level of Percy River has decreased from 1998 until the present. This trend is maintained both in the high-water pulses (rainy season and meltwater) and in the low-water pulses (summer season). In year 2017, a record well above mean river level is observed, associated with an extraordinary storm and the accumulation of large amounts of snow throughout the region and not associated to rainfall, which was within mean values (870 mm) (Figure 8a). In winter 2012, there was a heavy snowfall, even in the cities.

Figure 7. Transitions of a) the main lakes in the Esquel area and b) the Percy and Corintos rivers in the Trevelin area. (Source: FEE 6.6.1).

To analyze whether there is a correlation between climatic variables (accumulated precipitation) and water courses levels, winter months' data, where rainfall is the main water input to the fluvial systems, were studied. The variables correlated positively (r=0.60), indicating the same downward trend for both variables, although they were more abruptly in relation to river level (Figure 8*b*).

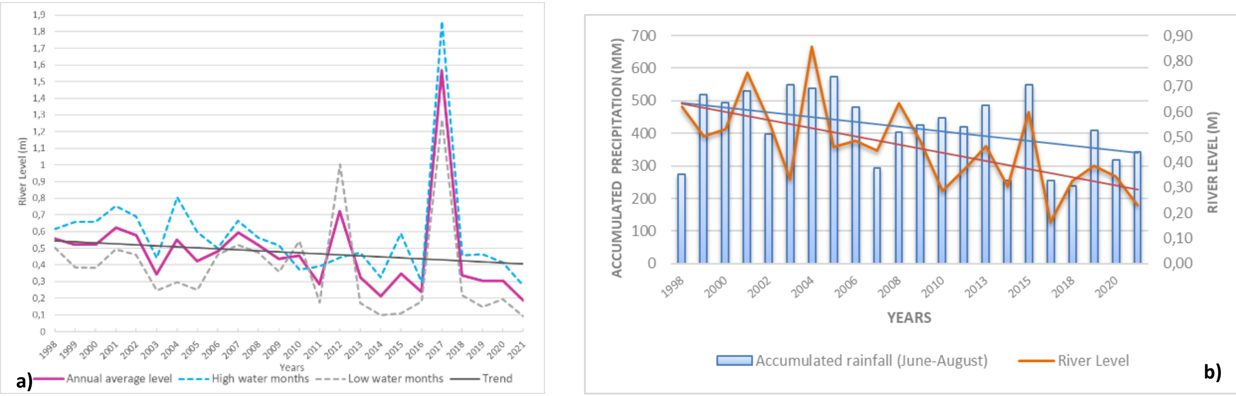


Figure 8. a) Mean values of the Percy River levels at a permanent monitoring station located in Paraje Rural - Upper Percy River. b) Accumulated rainfall value of the rainy season compared to river levels *(*Source: Hidroeléctrica Futaleufú, 2022*).*

With regard to Patagonian wetlands, it is not possible to estimate the indicators by means of the explorer because of existing limitations regarding the work scale. Therefore, the creation of a wetlands' inventory is necessary to improve knowledge and information on these ecosystems in order to make decisions related to their conservation and rational use.

It was not possible to analyze the variation in the flow rates of the Subbasin because there was no continuous monitoring that would allow us to have reliable historical data.

Quality of aquatic ecosystems and their waters

The water quality of the aquatic environments of the Subbasin has been the subject of numerous studies in recent decades. These studies have focused mainly on the two urban centers (Esquel and Trevelin), although comprehensive recent studies have also studied the impacts produced by other activities (Miserendino et al. 2016, 2021, Horak et al. 2019, 2020). Together with the measurement of physicochemical parameters, it is quite common to use biological indicators, among which the benthic macroinvertebrate community is the most widely used as an indicator of environmental quality. Its suitability lies in the wide range of responses exhibited by the species, the duration of their life cycle (8 to 24 months) and their fidelity to the environment. Among the most responsive indicators are the combination of pollution-intolerant taxa (EPT: Ephemeroptera, Plecoptera and Trichoptera), the increased density of pollution-tolerant species (Hirudinea, Oligochaetes, etc.) and functional food groups.

In the upper-middle stretch of the Esquel and Percy Subbasins, dissolved oxygen levels are good, and conductivity and nutrients are within normal values for the region. However, the bioindicators for these stretches reveal signs of an emerging environmental degradation. The decrease in species of the EPT group, evidences signs of sedimentation and erosion processes caused by the loss of vegetation cover (Miserendino et al. 2016).

The middle stretch of the basin shows signs of severe organic pollution due to urbanizations, which is already evident in studies carried out in 1999, when high values of BOD_5 and nutrients were recorded (Miserendino & Pizzolón 2000, Pizzolón & Miserendino 2001). This situation has worsened since then, despite the various interventions carried out in the Esquel stream. The most recent studies show a further deterioration in water quality in the stretch of the river downstream of the PTLC, with nutrient concentrations reaching extreme values (total nitrogen 11,018.2 µg/l, ammonium 10,628.9 µg/l, and soluble reactive phosphorus 1,413.1 µg/l) (Assef et al. 2014) and bacteriological analysis exceeding the levels allowed by legislation (MAyCDS 2022). But it has also been documented that the deterioration of water quality has expanded to other urban stretches of the Esquel Stream prior to the PTLC discharge ((Williams-Subiza 2021). This coincides with the results obtained by the MAyCDS for Esquel Stream in recent years' monitoring (2019-2022), with fecal coliform concentrations above the guideline levels allowed for recreational waters in almost all sampled points in the city. In areas affected by organic contamination, the EPT group disappeared completely, with more tolerant groups being found instead. The self-depuration process, that was observed in previous studies, has been lost as a consequence of the intensity and duration of the disturbance.

The situation in the Percy River is similar, tempered by the higher water flow and lower population density. Works carried out in 2010 and 2018, with seasonal periodicity (Bauer 2010, Williams-Subiza 2021, respectively) show that the urban and post-urban reaches of the Percy River present a high nutrient concentration compared to the upper basin. The deterioration of water quality is evidenced by high values of conductivity, BOD_5 , phosphates, ammonium and total coliform bacteria. This situation is observed from the mouth of Esquel Stream entering the Percy River and worsens downstream as it flows through the city and receives the effluents discharge from the Trevelin PTLC, where BOD_5 reaches values of 100 mg/liter and bacteria 30,000 (UFC), indicating a substandard performance of the plant. The bacteriological results of the stretches associated with the PTLC and downstream show values well above the permitted levels for recreational waters in direct and indirect contact both in total coliforms and in *Escherichia coli* and fecal Enterococci (MAyCDS 2022).

In the Percy River, the impact on the macroinvertebrate community was less pronounced than in the Esquel Stream, pollution-sensitive groups (EPT) persisted in some urbanized sites. However, certain signs of water quality degradation provided evidence of an increase in the density of tolerant taxa associated with disturbance and organic pollution, such as Oligochaeta and Hirudinea.

In the lower stretches of the Percy basin, under heavy agricultural-livestock use, Horak et al. (2019) report the effects of semi-intensive cattle breeding in tributaries of Corintos River. High values of suspended solids, conductivity, soluble reactive phosphorus, and total coliform bacteria were recorded in the worst cases. The biotic indicators that best indicated the environment degradation were the disappearance of sensitive groups, decrease in the number of insect families, increase in the density of tolerant groups, the collector-gatherers functional feeding groups, and total density of invertebrates (Horak et al. 2020).

The native forests of the upper basin are also suffering degradation processes. Lenga and ñire represent over 90% of the native forests of the region. Forty percent of the forests of the basin are represented by *Nothofagus antarctica* (ñire) forests, which are generally used for sheep and cattle breeding in sylvopastoral systems, without adequate management that ensures the integrity of the system (Peri 2004). This lack of management has generated different levels of degradation, from incomplete forest cover to completely bare soil or soil covered with not very palatable herbaceous species (Hansen et al. 2008). Lenga forests are considered to be protection forests because they are located at the headwaters of the basins.

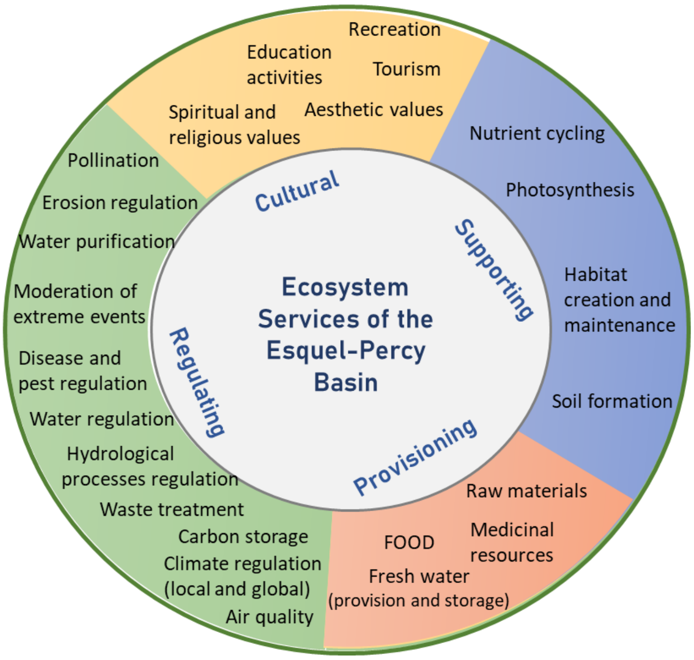
On the eastern border of the Subbasin, it can be observed a loss of cover and diversity of trees and shrub strata (Bava et al. 2012), and an increase in subshrubs and herbs characteristic of xeric environments. This is why the relictual *Austrocedrus chilensis* forests, that have been recorded, (Rost 2016) are areas of interest for conservation and restoration (DGByP 2010; La Zeta Lagoon Urban Natural Reserve Management Plan).

An erosion risk analysis of the Percy River basin showed that an 8% of the basin surface (7,950 hectares) faces moderate (6.6%) and high (1.4%) rainfall erosion processes. These areas mainly occupy the headwaters where the tributaries drain through *Nothofagus pumilio* (lenga) forests. The erosion risk of some lands with moderate slopes associated with the urban and suburban area of Esquel was also classified as moderate to high (Miserendino et al. 2016).

In the Subbasin, the quality of riparian vegetation shows signs of alteration and loss of quality in several stretches. In the extensively grazing areas of the basin, the quality of the river banks vegetation, graded with the QBRp index (Quality Index of Riparian Forests of Patagonian Rivers) (Munné et al. 1998; 2003; Kutschker et al. 2009), shows signs of disturbance, with stretches of intermediate quality mainly as a consequence of the loss of vegetation cover and structure. In the middle stretches, greater signs of disturbance are observed, and quality values decrease, thus revealing poor quality especially in the urban stretches. The main causes are the loss of vegetation structure and of native species, the spread of exotic species forming dense galleries, and modifications in the fluvial channel and adjacent terraces (Papazian & Kutschker 2008; Papazian 2009; Miserendino et al. 2020). In the Esquel Stream, the quality of the river banks gradually diminishes with altitude, reaching a poor quality in urban stretches. This is especially present in the sectors where the channel has been rectified and channelized, disconnecting the river banks from the river. There is an almost total replacement of riparian forest in the lower stretches of the courses, and colonization from the middle stretches towards downstream of exotic willows *Salix fragilis, S. alba* and *S. X rubens* forming dense gallery forests (Papazian 2009; Miserendino et al 2016).

2.6. Ecosystemic services

The Subbasin benefits from important environmental goods and services provided by aquatic ecosystems and surrounding terrestrial support systems.



3. Plan formulation process

According to certain application conditions, between September 17 and 21, 2021, the Focal Point through the SIyPH, COHIFE and COFEMA (federal coordination organizations) issued a call to APN decision-makers and to water and environmental sectors of the provinces. The call proposed to present key freshwater aquatic ecosystems and/or basins to be submitted to a prioritization process that would allow choosing, in a concerted manner, the issues to formulate action plans. In addition, on October 1, a governmental webinar was held, focused on the call, where the criteria for the prioritization and selection of ecosystems were established.

Between October 15 and 17, four applications were received and, in the framework of the Local Coordinating Group, prioritization was agreed upon based on the degree of compliance with the criteria. As a result, two areas with different biogeographic conditions were selected: the basin of Marapa San Francisco River and the Esquel- Percy System (Figure 9).

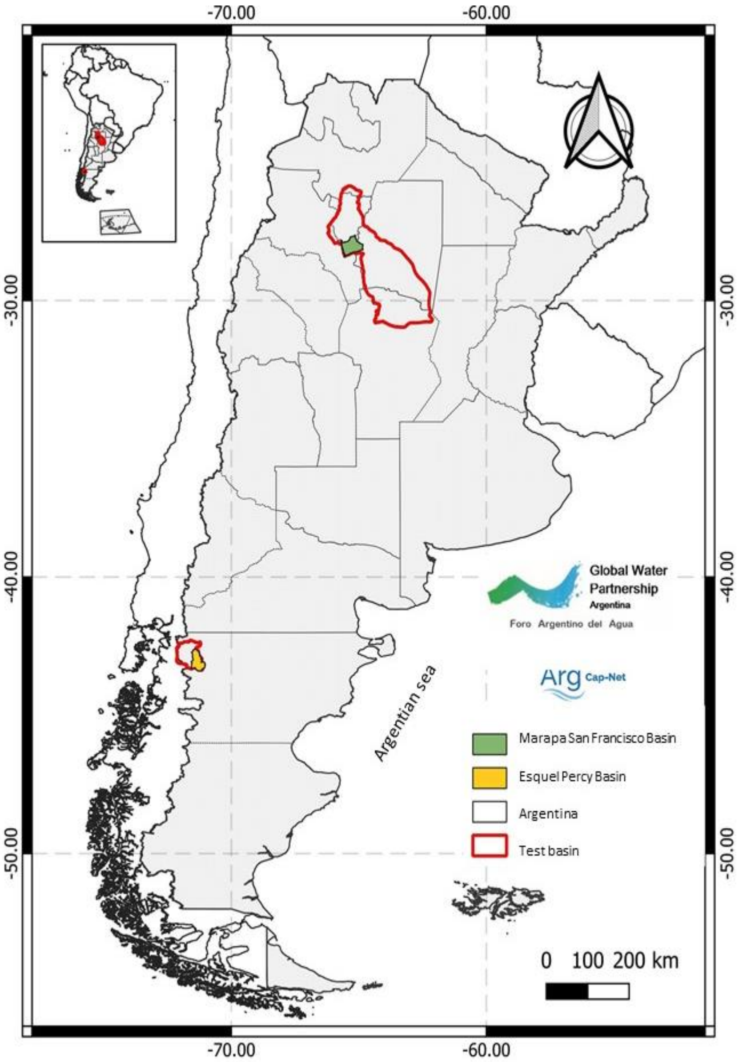


Figure 9. Location map of the selected sites in Argentina for the formulation of action plans within the framework of the Pilot Project.

Given the large geographical extension of the country and the ease of holding face-to-face meetings, local consultants were hired to formulate action plans that were proposed by those responsible for water and environmental management in the provinces involved.

On November 23, the development of the Esquel-Percy System Plan began with the formation of the Esquel-Percy System Working Group, which includes the responsible provincial authorities: Jorge Reinoso (Institutional General Director of the General Administration of Water Resources) and Carolina Humphreys

(Undersecretary of Environmental Management and Sustainable Development) of Chubut Province and Consultant Gabriela Papazian, who worked closely with the *Local Coordination Group* (GLC): Fernanda Gáspari and Marcos Cipponeri for Arg Cap Net, Ana Mugetti and Leandro Días for FAdA, Laura Benzaquen and Francisco Firpo Lacoste for the Focal Point and Silvia de Simone for the Secretariat of Infrastructure and Water Policy (SIyPH).

The stakeholders for the Plan Formulation process were identified: 20 relevant institutions and organizations, including federal organizations, national, provincial and municipal government institutions, national science and technology institutions, water users (including agricultural producers, safe water and effluent treatment service providers), and social organizations involved in the care of the basin's aquatic environments.

The initial analysis as well as the subsequent selection of actions were based on multiple contributions. These inputs came from scientific-technical data and research, interviews with key actors, and participatory workshops with stakeholders. The interviews were conducted personally (face-to-face or virtually) to gather information on data, policies, institutional strategies, plans and programs. Two workshops were organized in February, obtaining a Pressure map (figures included in the Annex) and impacts on the basin and its drivers; and a preliminary action plan identifying the priorities, execution times and potential institutions involved in the implementation. The division into short, medium and long-term actions was guided by the stakeholders' assessment of their own institutional capacities. The second workshop was joined via Zoom by members of the GLC. Finally, a third workshop was held with the presence of all relevant local institutions; the final version of the Action Plan was presented, some steps to be followed as well as coordination and follow-up mechanisms were discussed, and the institutions leading the execution of short-term actions confirmed their commitment. On this occasion, members of the GLC joined again virtually.

For the selection of the short-term plan, we worked with the responsible provincial authorities, who agreed on the prioritization of actions, and the institutions that agreed to promote the actions. Throughout the process, information on the formulation of the plan was shared with the population through governmental and private digital media, and over the radio.

4. Objectives

The general objective is to protect the ecosystems associated with freshwaters of the Esquel-Percy System, conserving and restoring their biodiversity and functionality, and recovering goods and services in the context of climate change and urban expansion.

5. Actions for the conservation and restoration of the aquatic ecosystem

The following are the actions resulting from the initial ecosystem analysis deemed necessary to recover and conserve the aquatic ecosystems of the Esquel-Percy basin. The general approach was based on the identification of actions in a participatory manner among key stakeholders from governmental, private and community organizations. The actions prioritized to be carried out in the Short-term were selected at working meetings, including the provincial coordination. Some actions related to the delimitation of riparian lines, eradication of clandestine effluent discharges and their efficient treatment were considered a priority although it is not feasible to carry them out in the Short-term. Likewise, the detection of the effluent discharge points in the Esquel Stream will be carried out in the Short-term. The MAyCDS in coordination with the Municipality of Esquel will complete the eradication action in the Medium-term.

The actions are framed in seven Programmes.

6. Action plan

Programme 1: Return water to streams, rivers and lagoons				
Objective	**Code**	**Projects/actions**	**Expected result**	**Completion time**
Optimize and reorder the water use in the basin	 1.1 1.2	**Project 1:** Implementation or extension of the metering system in the residential supply of safe water Extension of the metering system in the residential supply of safe water in the city of Esquel Implementation of the metering system in the residential supply of safe water in the town of Trevelin	Reduction in the per capita water volume consumption in the cities of Esquel and Trevelin	Short-term Medium-term
	 1.3 1.4	**Project 2:** Provision of new water supply sources for human consumption Execution of a new water collection work for complementary supply to the safe water system of the city of Esquel Stopping or reducing the use of surface waters currently used for human consumption	Increase Esquel stream flow by reducing water extraction for consumption	Medium-term Medium-term
	 1.5 1.6	**Project 3**: Optimize the use of the basin's water for production purposes Reorganization and design of the use of basin's water Implementation of more efficient modalities for a sustainable use of irrigation water in production systems	Reduction of water consumption volume, resulting from the incorporation of more efficient irrigation systems	Medium to Long-term Short-term
Water reuse in the basin	1.7	**Project 4**: Reuse of wastewaters Design and implementation of projects for the reuse of treated household effluents in production systems and others	Environmental: reduction of diversions, improvement of water quality and of the aquatic system in general. Socio-economic: supply of treated wastewater in summer season, potential reduction of fertilizers' use and decrease of socio-environmental conflicts with users of surface natural sources.	Medium-term

Programme 2: Sanitation of streams, rivers and lagoons				
Objective	**Code**	**Projects/actions**	**Expected result**	**Completion time**
Improve water quality		**Project 1**: Efficient treatment of sewage effluents		
	2.1	Improvement of the systematic assessment of the effluents treatment systems' capacity and efficiency	The treated effluents comply with the levels allowed by current legislation	Medium-term
	2.2	Improvement of the periodic and systematized control of water quality in urban and peri-urban sectors		Medium-term
	2.3	Adequacy of the treatment systems according to current regulations		Medium-term
		Project 2: Stopping discharges of untreated sewage effluents	Identification and elimination of the clandestine waste discharges to water courses or water bodies.	Medium-term
	2.4	Feasibility analysis of access to the sewage system		
	2.5	Evaluation of other alternatives for the treatment of residential sewage effluents	Increase of population with access to sewage system services.	Medium and Long-term

Programme 3: Conservation and restoration of water related ecosystems				
Objective	**Code**	**Projects/actions**	**Expected result**	**Completion time**
Protect or improve the ecosystems' ecological quality within the basin		**Project 1**: Recovery of ecosystem services in aquatic environments	Improvement of the functionality of aquatic ecosystems and the ecosystem services they provide, such as the reduction of nutrients and fecal bacteria in water, and the reduction of banks and river banks erosion.	
	3.1	Completion of the executive project: High water Control Master Plan for the Sanitation of Esquel Stream		Medium to Long-term
	3.2	Control and management plans of Salicaceae on riparian areas of streams and rivers		Medium to Long-term
	3.3	Implementation of restrictions on livestock access to watercourses and bodies of water		Long-term
	3.4	Revegetation of riverbanks in the upper basin with native species		Short-term
		Project 2: Recovery of ecosystem services in forest environments	Recovery of the structure and functionality of soils and vegetation in forest ecosystems of the basin	
	3.5	Promotion of Forest Management Plans with Integrated Livestock		Medium-term
	3.6	Restoration of degraded areas in terrestrial environments based on a multi-criteria analysis contemplating environmental, social and economic variables		Medium to Long-term

Programme 4: Territorial planning and management in public use areas				
Objective	**Code**	**Projects/actions**	**Expected result**	**Completion time**
Organize the use associated to the aquatic ecosystems withing the basin		**Project 1**: Management and control of public spaces associated to aquatic systems	Planning and management guidelines for different areas of the basin, in particular the recreational use areas, minimizing impacts and promoting good environmental and social practices.	
	4.1	Overall territorial planning for cities, their productive peri-urban and unurbanized areas		Medium-term
	4.2	Formulation and implementation of water use and territorial planning management instruments		Medium to Long-term
	4.3	Development of Management Plans for the Urban Natural Reserves of the Subbasin		Medium-term

Programme 5: Environmental education and training on water management				
Objective	**Code**	**Projects/actions**	**Expected result**	**Completion time**
Promote and raise awareness on the sustainable use of water		**Project 1**: Environmental education for responsible water use	To provide knowledge and useful advice on responsible water consumption and its reuse both in residential and the production farms	
	5.1	Design and implementation of formal and non-formal environmental educational programs on the sustainable use of the resource		Short-term
	5.2	Strengthening prevention actions to avoid direct impacts on the water cycle, aquatic ecosystems and human health		Medium to Long-term
		Project 2: Training in water technologies and water management applied to production	Adoption by producers of efficient irrigation techniques to reduce water consumption with equivalent productivity	
	5.3	Transfer of a technological package for the rational sustainable use of water in production establishments		Short-term

The Ministry of Environment and Control of Sustainable Development (MAyCDS), through its Directorate of Environmental Education and Communication, poses these measures as "Situational Strategic Planning" with a participatory approach. This approach contemplates a first "explanatory" work phase that includes the analysis of the situation identifying existing gaps and all the necessary and relevant information, among other things, to plan actions. The transfer modality will be the result of this planning, using pedagogical and communicational tools suitable for each community or sector with whom we are going to work both in formal and non-formal education fields.

Programme 6: Formulation and enforcement of regulations through inter-institutional strengthening and articulation				
Objective	**Code**	**Projects/actions**	**Expected result**	**Completion time**
Design follow-up mechanisms for interinstitutional actions related to water uses, sanitation and water management (in aquifers, rivers, wetlands).		**Project 1**: Improvement in water management	Coordinated and cooperative work between institutions involved in water management (IPA-MAyCDS-Municipalities).	
	6.1	Review of laws, regulations and permits that contravene human right to water and a healthy environment		Medium-term
	6.2	Compliance with regulations requiring the delimitation of river banks lines within the basin		Medium to Long-term
	6.3	Definition of an enforceable action protocol for sediment removal along riverbanks		Short-term
	6.4	Monitoring and evaluation of the results and impacts of inter-institutionally articulated programs and projects		Mediano y Largo Plazo
	6.5	Development of a legal framework that provides certainty to stakeholders, in participation spaces, to improve water governance		Medium-term
		Project 2: Strengthening of control mechanisms	Activity control in a coordinated manner between responsible institutions (IPA-MAyCDS-Municipalities).	
	6.7	Implementation of efficient controls and penalization of violators for non-compliance with surface water use regulations		Medium-term

Programme 7: Generation of information and monitoring of the state of aquatic ecosystems

Objective		Projects/actions	Expected result	Completion time
		Project 1: Generation of a unified environmental database for the integrated management of the basin	Storage, conservation and access to data generated by monitoring.	
	7.1	Strengthening of the environmental information system in a collaborative manne		Short-term
	7.2	Interpretation of data and preparation of a report every six months	Biannual report with observed changes in water quality and quantity indicators	
	7.3	Wetlands Inventory in the basin area in accordance with the methodology established in the development process of the National Wetlands' Inventory	Contribution to the National Wetlands' Inventory	Medium-term
				Medium-term
Generate and count with information to improve decision making		**Project 2:** Generation of ecological information on aquatic environments	Annual report on the ecological state of watercourses and water bodies	
	7.4	Application of habitat and river banks quality indices to assess the ecological quality of aquatic ecosystems at strategic points in the basin		Medium-term
		Project 3: Comprehensive monitoring plan for the entire basin	To have reliable information, using a single methodological framework and an appropriate sampling frequency for the monitoring of physicochemical and biological indicators of water quality and quantity in the ecosystems	
	7.5	Extension of the aquatic ecosystem monitoring program in an integrated manner in the upper, middle and lower basin		Short-term
	7.6	Formulation and implementation of an integrated wetland monitoring program in the upper, middle and lower basin		Medium-term
	7.7	Systematic measurement of hydrological variables in fluvial systems		Short-term

7. Short-term action plan

The implementation of a plan with such characteristics is an unprecedented initiative in this region, not only because of the number of institutions involved, but also due to the microregion logic that is founded on the collaboration among the various municipalities of the basin.

The actions' success will depend on environmental and technical variables, as well as on the social acceptance and support, among other aspects. The responsible organizations have expressed their commitment to lead the actions' implementation. However, the first difficulty to be resolved will be the funding of short- and medium-term actions. In a first approach, USD 5,402,000.00 will be necessary for the initial implementation of the plan during the next 4 years. Part of these funds correspond to already existing budgets at the institutions, thus not requiring additional expenditures; while in other cases, the management of funds is an unavoidable intermediate action for the execution of planned actions. With regard to the implementation phases, three feasible stages were considered: Pre-investment, Execution (or investment), and Follow-up and evaluation. Pre-investment includes the stages that go from the search for funding for the Project development to the beginning of its execution; the Execution includes the implementation of the measure and/or the work; and the follow-up and evaluation is used to monitor that the Projects are executed in due time and proper form, to observe the compliance with regulations, practices or other aspects, and the impact resulting from the execution.

The Expansion action of the monitoring program, specified in Programme 7, includes the incorporation of at least four new sampling sites to the existing ones and relevant analysis parameters (especially nutrients) for the comprehensive monitoring of the basin.

The order of the Programmes and Projects does not necessarily indicate a hierarchical priority.

Roadmap for the implementation of the short-term measures

	Name of action	Result	Implement - ation phase	Responsible for execution	Indicator	Schedule 2022	2023	2024	2025	Approximate cost (USD)	Potential funding sources
Programme 1	Extension of the metering system in the residential supply of safe water in the city of Esquel	Implementation of 5,000 residential micrometers	Execution	16 de Octubre Cooperative, guaranteed by Esquel Municipality	Number of installed meters		x	x	x	2,200,000	ENHOSA Private (Cooperative and users)
	Implementation of more efficient modalities for a sustainable use of irrigation water in production systems	Improved technologies and infrastructure to increase the efficiency of irrigation systems	Execution	Trevelin Municipality, Secretariat of Production	Number of farms that incorporated improve-ments in their irrigation systems	x	x	x	x	2,900,000	MDP. (Green Productive Development), MAGyP (FONDAGRO), Banco Nación Loans, FONTAGRO
Programme 3	Revegetation of riverbanks in the upper basin with native species	Seed harvesting, seedling production and planting of native species in Percy River upper basin. Livestock access closures.	Execution	Secretariat of Forests of Chubut Province	Number of kilometers of revegetated riverbanks	x	x	x	x	100,000	Funds of Native Forest Law (Nr.26.331)
Programme 5	Design and implementation of formal and non-formal environmental educational programs on the sustainable use of the resource	It is transversal to all actions.	Execution	MAyCDS	Population reached	x	x	x	x	100,000	National State and other National and International Credit Organizations. Federal Investment Council (CFI)
	Transfer of a technological package for the sustainable use of water in production establishments	Training and technical advice for irrigated productions	Execution	INTA	Number of producers reached	x	x	x	x	15,000	Own funds of the Institution
Programme 6	Definition of an enforceable action protocol for sediment removal along riverbanks	To have a clear and formal inter-institutional procedure for riverbanks' sediment removal activities	Execution	IPA, MAyCDS and Municipalities	Manual or protocol prepared.	x	x			2,000	Provincial funds

	Name of action	Result	Implement - ation phase	Responsible for execution	Indicator	Schedule				Approximate cost (USD)	Potential funding sources
Programme 7	Strengthening of the environmental information system in a collaborative manner	Unification and complementation of environmental information by incorporating data into SPIA from multiple stakeholders	Execution and monitoring	MAyCDS	Effective incorporation of new data to the Provincial Environmental Information System	x	x	x	x	10,000	Institutional management and provincial funds
	Extension of the aquatic ecosystem monitoring program in an integrated manner in the upper, middle and lower basin	Incorporate sampling sites and parameters to the program. Acquisition of computer equipment and in situ parameter measurement equipment.	Execution and follow up (monitoring)	MAyCDS	Effective incorporation of sites and equipment to the monitoring programme		x	x	x	35,000	Federal Investment Council (CFI)
	Systematic measurement of hydrological variables in fluvial systems	To have monthly data on the main hydraulic variables of Percy River and Esquel Stream.	Execution and follow up (monitoring)	IPA	Existence of data to produce a monthly series	x	x	x	x	40,000	Secretariat of Infrastructure and Water Policy of Argentina (SIyPH)

This general planning lists actions whose comprehensive description is included in the formulation of the Programmes, especially in those cases where the presentation of Projects is required for funds management.

It is worth noting that this planning may be reformulated for its implementation, pursuant to local agreements that are being reached, the precision level of the specific activity to be carried out and the overall allocation of funds.

8. Coordination and monitoring mechanism

The organization responsible for the Action Plan Coordination and Monitoring is the Futaleufú River Basin Committee, since actions of this type are framed within its statutory attributions. This Committee is an organization with legal state and capacity to act in the field of public and private law; it is made up of the Governing Board and the Executive Committee (chaired by IPA). The representation is exercised by the President of the Governing Board, consisting of representatives of the Provincial Executive Branch, municipal representatives of the basin, as well as representatives of National Parks Administration and the various types of users (livestock, tourism, residential) and of scientific-technical institutions. The Committee is chaired by one of the representatives of the provincial government. It is worth mentioning that the Committee has participated in all phases of the plan formulation process, that this undertaken commitment will strengthen its capacities, and that it will effectively comply with the powers conferred upon it.

The composition of the Committee largely coincides with the participants of the planning process, so it can be expected that the undertaken commitments will be a priority for all stakeholders. This should pave the way for the achievement of the proposed objectives, since the committee members themselves identified the problems to be solved and their possible solutions to achieve the sustainable development goals.

Sharing a work plan and having common objectives will result into a more harmonious, efficient and effective operation that will strengthen the institutional capacities of both the Committee and its members.

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Annexes

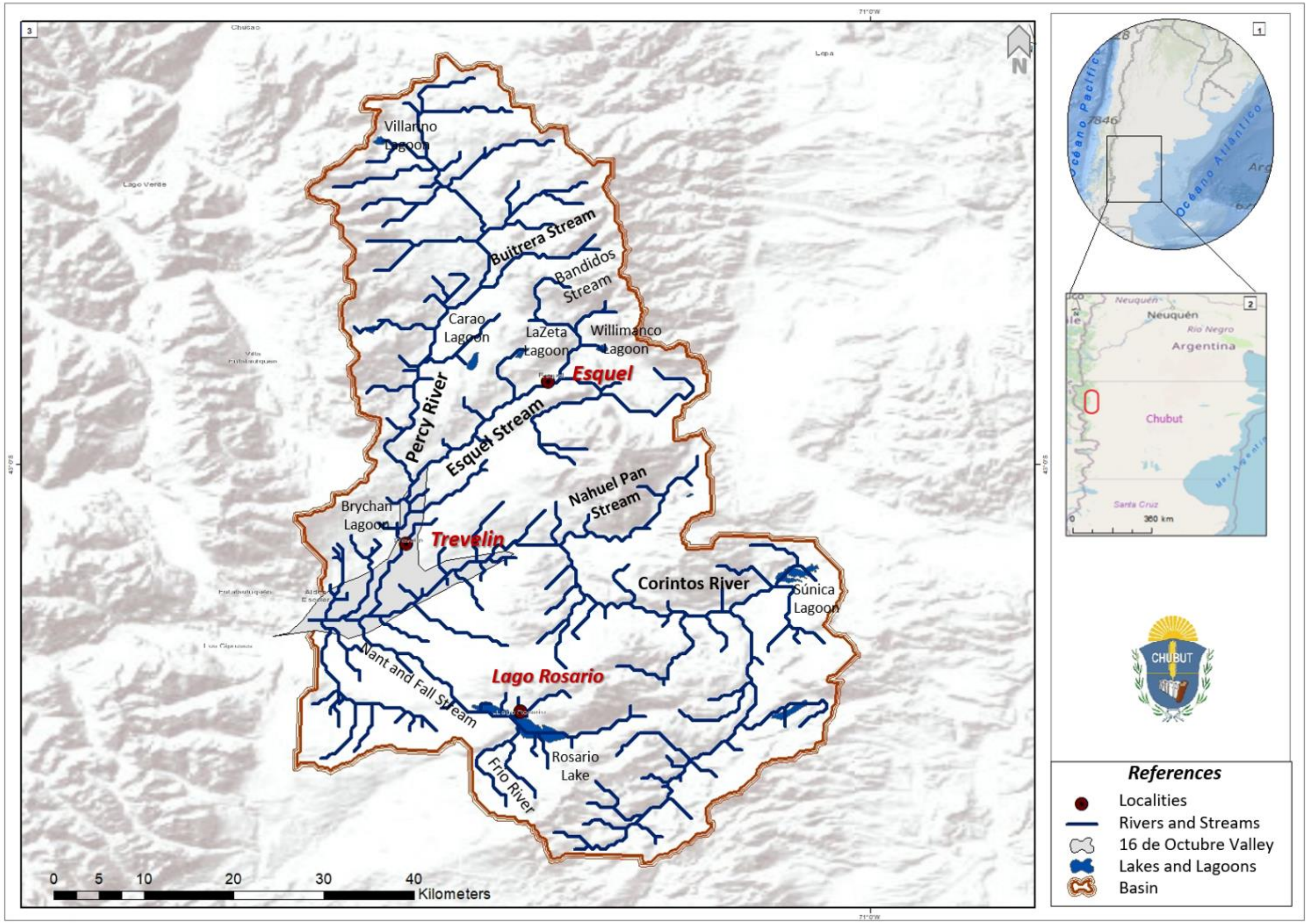

Figure 3. Hydrological system of the Esquel-Percy subbasin and its hydrological system (Source: *IPA)*

Table 1. Pressures that directly or indirectly influence the state of the aquatic ecosystems of Esquel-Percy System basin

<table>
<tr><th>Pressure drivers</th><th>Pressures</th><th>Ecosystem state</th><th>Impacts</th></tr>
<tr><td rowspan="2">Extensive livestock farming</td><td>Livestock access to watercourses and bodies of water</td><td>River banks of rivers/streams and wetlands with signs of erosion by trampling.
Concentration of nutrients from excrement (nitrates, phosphates and ammonium), especially in lagoons and Patagonian wetlands.
Discontinuous riparian forests with little natural regeneration</td><td>- Increase of fine sediments in aquatic environments.
- Eutrophication of lagoons and Patagonian wetlands
- Algae blooms and increase in macrophytes.
- Changes in the structure and composition of biological communities.
- Decrease in habitat quality due to replacement of forests by pastures.
- Loss of functionality of river banks forests (ecosystem services)
- Loss of ecosystems' resilience</td></tr>
<tr><td>Overgrazing or continuous grazing</td><td>Ecosystems of forests and Patagonian wetlands modified in their structure, quality and degree of vegetation cover, and changes in land use that affect other environmental components such as soil, water, and air.</td><td>-Loss of biodiversity
-Changes in vegetation structure
-Soil degradation
-Competition for resources with native herbivores
-Loss of native forest regeneration due to herbivory
-Loss of ecosystem services in the headwaters of the basin water system.
-Homogenization of Patagonian wetlands vegetation
-Loss of water quality in the Patagonian wetlands.</td></tr>
</table>

			-Facilitation of the establishment of exotic species. -Erosion and sediment transport to the watercourses by runoff.
Intensive livestock farming	Concentration of large volumes of manure and urine High water demand for animal consumption (especially in summer)	Aquatic environments modified in their physicochemical and biological conditions. Soils and aquatic environments with increased nutrient inputs (nitrates, phosphates and especially ammonium), veterinary drug residues and fecal bacteria, by leaching or runoff. Ecosystems degraded by soil compaction and loss of vegetation cover. River flows diminished by diversions.	-Eutrophication of water bodies and watercourses. - Risk to human and animal health - Decreased recreational use capacity - Diffuse sources of pollution -Soil compaction through trampling - Loss of biodiversity - Invasion of exotic plants - Modification of soil structure - Alteration of the composition and abundance of aquatic communities. - Loss of ecosystem services - Loss of ecosystems' resilience

Forest exploitation	Intensive logging, without a management plan, in the lands surrounding the aquatic ecosystems of the upper basin	Forest ecosystems modified in their structure, quality and degree of vegetation cover and changes in land use that affect other environmental components such as soil, water and air.	- Transformation of forest into scrubland and pastureland - Loss of native species - Water erosion and soil loss (especially in areas with steep slopes). - Increase in surface runoff and decrease in infiltration. - Increased sediment in streams - Formation of sediment banks downstream - Loss of ecosystems' resilience
Agriculture: Pasture/fruit-vegetable crops.	High water demand for irrigation Leaching of surplus fertilizers and agrochemicals	Aquatic environments with diminished flow due to diversions. Aquatic systems functioning as a sink for nutrients and pesticides from agricultural activities	- Eutrophication - Loss of habitat quality and aquatic biodiversity. - Loss of ecosystem services - Decrease in recreational use capacity. - Changes in the composition and abundance of aquatic communities. - Diffuse sources of pollution - Loss of ecosystems resilience

Urbanization: Overload/ / Inefficiency in the effluent's treatment*	Chemical and bacteriological occasional contamination (especially soluble reactive phosphorus, ammonium, nitrates, nitrites, fecal-coli)	Fluvial systems with a high concentration of nutrients, due to the input of sewage liquids without adequate treatment, with the consequent loss of water quality	- Eutrophication - Increase in water temperature and turbidity - Decrease in dissolved oxygen - Risk to human and animal health - Decreased recreational use capacity - Loss of fluvial habitat quality - Alterations in the composition and abundance of aquatic communities. - Loss of ecosystems' resilience
Urbanization: Discharges: residential clandestine dumping along the river banks*	Chemical and bacteriological occasional contamination (especially soluble reactive phosphorus, ammonium, nitrates, nitrites, fecal coli).	Degraded fluvial systems due to occasional pollution caused by the discharge of untreated sewage liquids in specific urban stretches of the watercourses.	- Eutrophication - Loss of water quality. - Risk to human and animal health - Decreased capacity for recreational use. - Loss of habitat quality - Changes in the structure and composition of biological communities.
Urban expansion in urban-forest interface zones	Fire risk New water catchments and preventive storage systems.	Landscapes in constant change due to urbanization advance, with the consequent modifications in the environmental conditions and the structure of the urban ecosystem.	- Loss of forest mass - Loss of private infrastructure risk (due to flooding or fire). - Habitat fragmentation - Decreased infiltration area and increased runoff

			- Loss of ecosystems' resilience
Urbanization: Water intakes and diversions for human consumption.	Extraction of water from surface, subsurface and groundwater systems	Fluvial environments with reduced natural flow. Stretches without water and others with stagnant pools, which causes the isolation of fish populations and other aquatic species, as well as the local disappearance of species associated with these environments.	- Loss of longitudinal connectivity of permanent watercourses. - Loss of regulating ecosystem services (decomposition of residues) - Decrease in recreational use capacity - Loss of biodiversity habitat quality - Loss of ecosystems' resilience
	Groundwater intakes for irrigation of small squares and in private homes	Modified subsurface aquatic systems	- Water volume decrease in the subsurface reservoir system
Agricultural activity	Presence of invasive exotic tree species along river banks (mainly salicaceae) and in watercourses	Riparian environments dominated by willow (*Salix* spp.), which forms closed and compact galleries, and within the riverbed its branches create deposits of sediment banks and dikes that retain sediments, altering the natural dynamics of the watercourse and river banks.	- Loss of biodiversity, particularly of native species. - Change in natural runoff of watercourses - Loss of ecosystems' resilience - Increased flood risk

Urbanization, farming, fishing.	Presence of exotic and exotic invasive species in watercourses and bodies of water (trout, didymo algae, Physa, among others).	Aquatic biological communities dominated by exotic species and displacement of native species due to competition.	- Loss of biodiversity - Loss of native species - Modification of trophic relationships
Construction of housing and infrastructure	Sediment removal within the riparian zones.	Riparian zones altered by the transit of trucks and heavy machinery, the temporary stockpiling of material along the river banks, and the modification of riverbeds	- Changes in riverbed morphology - Compaction of riparian soil - Bank instability - Decrease in water transport capacity - Increased water turbidity - Impact on biological communities
Tourism / Recreation Unplanned use of public spaces	Inefficient sewage and MSW management Risk of fires	Aquatic environments with increased concentrations of nutrients, fecal bacteria, microplastics and Urban Solid Waste in stretches used for recreational purposes during the summer season (Upper Percy, Esquel and Trevelin rivers).	- Eutrophication - Plastic pollution - Decreased recreational use capacity - Loss of habitat quality - Risk to human and animal health
Tourism / Recreation	Inefficient sewage waste management Access and runways *	Watercourse with increased nutrients, fecal bacteria and microplastics. Sediment contribution due to soil movement in steep sectors. Accesses with high concentration of sodium salts.	- Risk to human and animal health - Increased sediment generation, transport and discharge - Increased electrical conductivity, pH of water in upper stretch of the river

	maintenance tasks		
Climate: Climate change	Variation in hydrological regimes	Modified ecosystems based on hydrological changes and the rising of average temperatures.	- Droughts/desertification - Reduced aquifer recharge in basin headwater areas - Water supply deficit in the summer season
Cultural/Educational Population in general	Utilitarian view of nature Difficulty to have a systemic view of the basin Difficulty in learning and/or accepting new water use strategies Indifference or ignorance regarding the need for sustainable use of resources	Productive ecosystems using inefficient irrigation methods.	- Loss of longitudinal connectivity of permanent watercourses - Decrease in flow - Decrease in recreational use capacity. - Alteration in the composition and abundance of aquatic communities.

Non-compliance with Provincial Law Nr.1540/16 (new discharge levels)

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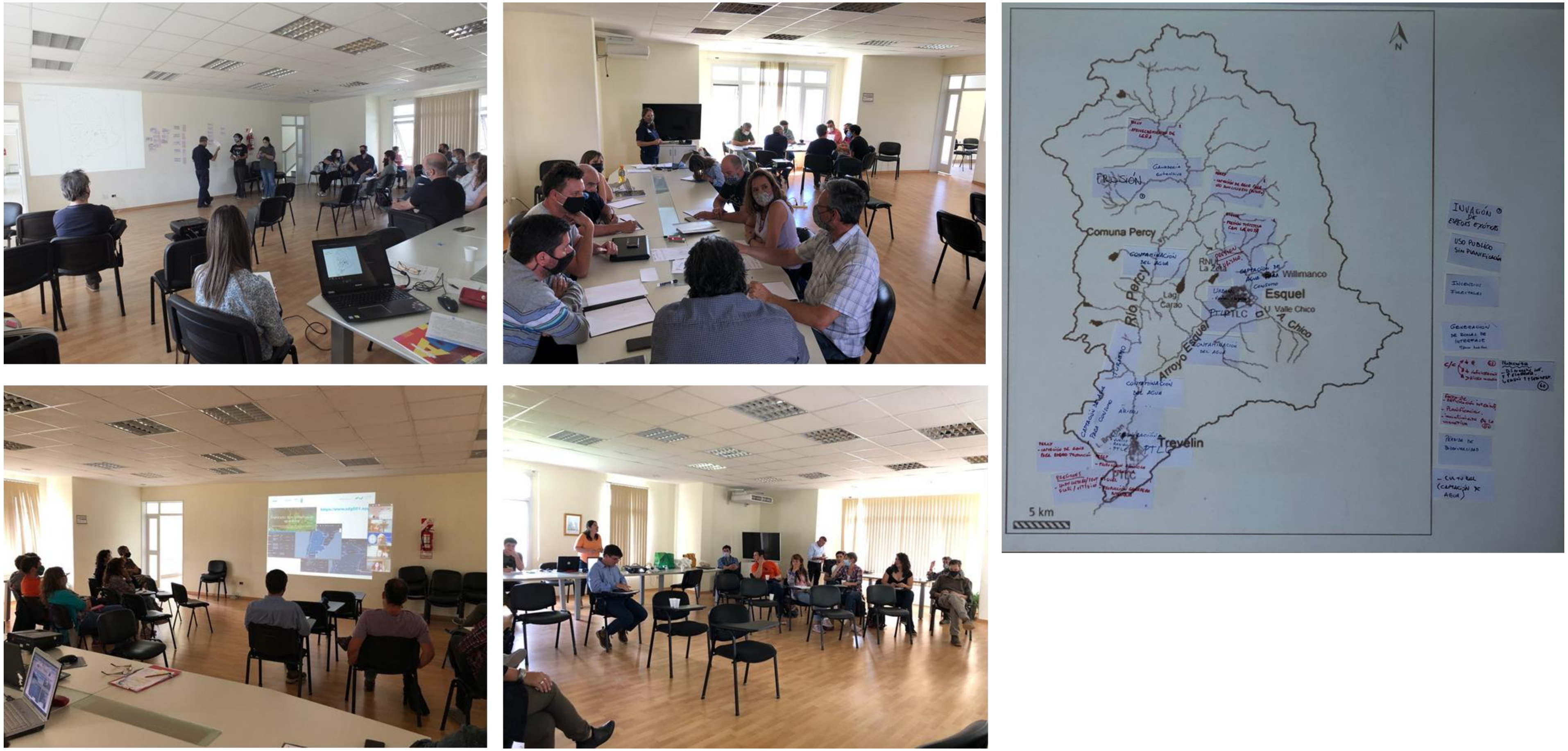

First and second workshop: Participants from different institutions working on the formulation of the Esquel-Percy System Action Plan; and the first product, the basin pressure map

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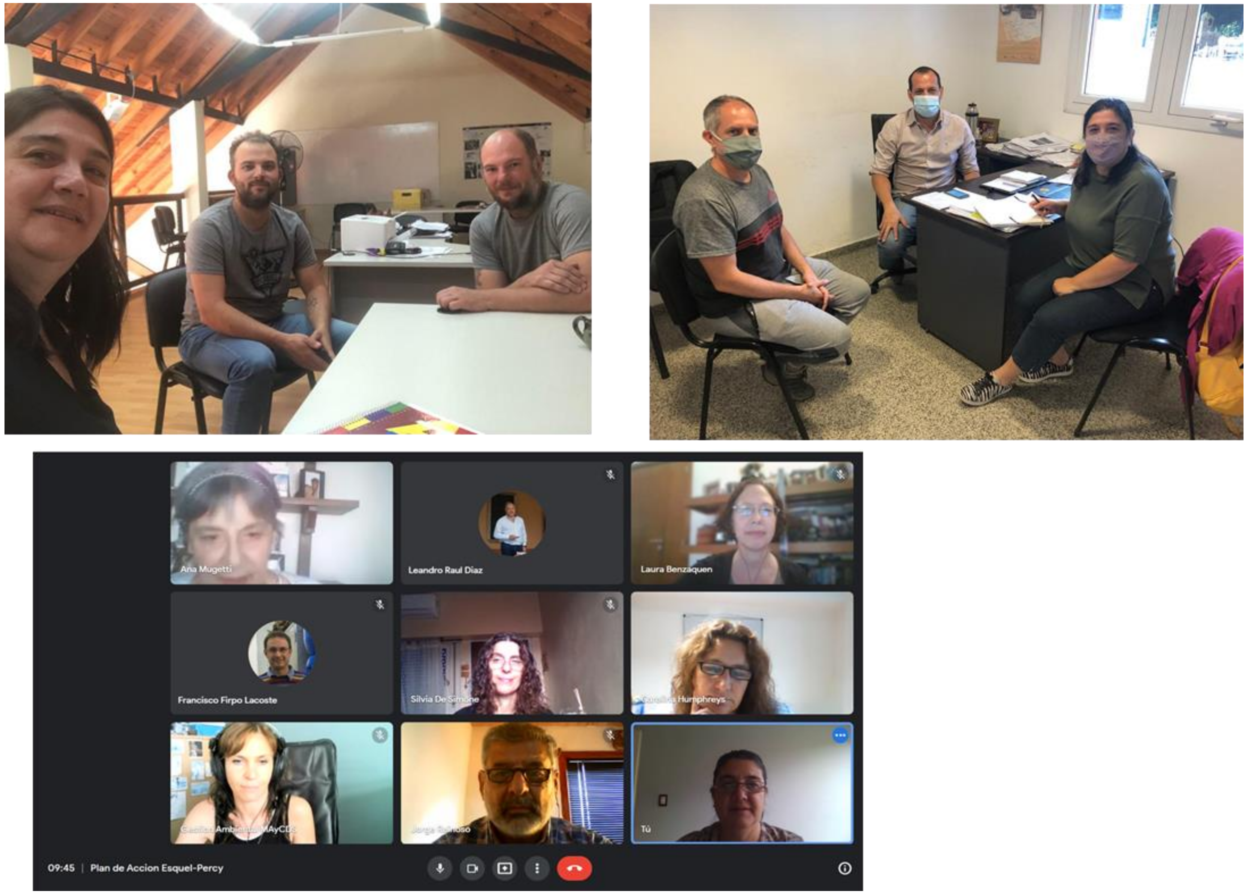

Consultative meetings with representatives of the municipalities of Trevelin (above left) and Esquel (above right) and Coordination meeting with members of the Local Coordination Group and Provincial Coordination (below).

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