GOOD PRACTICES for the Conservation and Restoration of HIGH ANDEAN WETLANDS

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CREDITS

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INTRODUCTION

The Ramsar Convention, signed in Ramsar, Iran in 1967, proposes the conservation and wise sustainable use of wetlands through local, national and international cooperation efforts (Ramsar, 2014). Within the framework of this Convention, the most current and relevant reports to this document correspond to the Regional Strategy for the conservation and sustainable use of high Andean wetlands (Ramsar Convention and EHAA Contact Group, 2008) and the Fourth Strategic Plan for 2016 - 2024 (Ramsar, 2015). The objectives developed in these reports require local and national implementation and, in addition, the exchange of information and experiences in order to adequately monitor the conservation status of wetlands and implement joint actions focused on their restoration. Therefore, the Ministry of the Environment, Water and Ecological Transition of Ecuador (MAATEE) in coordination with the Water Protection Fund (FONAG) managed the development of the project "Capacity Building and Experience Exchange of the Regional Initiative for the Conservation and Sustainable Use of High Andean Wetlands in Conservation and Restoration of Wetlands". The preparation of this document is a fundamental product of this project, contributing mainly to Objective 2 of the Regional Strategy and Operational Objective 4 of the Fourth Strategic Plan, which encourages the development of scientific and technical documents that promote the conservation and sustainable management of high Andean wetlands.

High Andean Wetlands (HAW), as defined by Ramsar, mainly include the following bioregions: páramos, jalcas, punas, and Andean Patagonia. These bioregions contain freshwater lakes and lagoons, salt flats, salt lakes, salt ponds, wetlands and peat bogs, hot springs and geysers, mallines, cattails, vegas and chuscales (Ramsar Convention and EHAA Contact Group, 2008). From Costa Rica to Argentina and Chile, and throughout the Andean Mountains, high Andean wetland ecosystems are located more than 2000 meters above sea level. In this document, reference will be made mainly to those saturated zones such as peatlands, wetlands, mallines and vegas. The HAW are characterized by their high biodiversity and the importance of their ecosystem services for the Andean region. Among the most important ecosystem services of the HAW are the provision of water, food, pasture for livestock and energy resources for Andean cities and communities and even for populations located in lowland areas; soil formation, maintenance of nutrient cycles and primary production; regulation of the water cycle and climate, as well as cultural, recreational, spiritual and religious services, cultural heritage and sense of identity. In particular, the provision of water and productive spaces of the HAW have enormous economic and cultural importance for Andean communities.

However, these ecosystem services are subject to climatic and non-climatic pressures. The most common non-climatic pressures include unsustainable practices such as water extraction for mining and agricultural uses, population increase leading to urbanization, fires, pollution, and poor land use and resource planning (Benavides, 2014; Ramsar Convention and EHAA Contact Group, 2008). In addition, climate change increases the pressure on the HAW, putting their functioning at risk. For example, the increase in temperature accelerates the decomposition of organic matter, which is one of the most important elements for water retention. At the same time, lower humidity and water saturation in the soil contribute to aeration and oxidation, decomposition of organic matter, loss of soil structure, among other effects, which accelerate and deepen wetland deterioration (Patiño et al., 2021). The decrease in water levels in wetlands, due to climatic and non-climatic factors, can transform their functioning from a carbon sink to a carbon source (Benavides, 2014; Planas-Clarke et al., 2020), which means that HAWs would not only be affected by climate change but would also contribute to enhance it. Therefore, the conservation and restoration of these ecosystems is of utmost importance for the maintenance of ecosystem services at local and global scales, as well as to contribute to climate change adaptation and mitigation.

Despite their importance and vulnerability, the extent of conserved areas and restoration practices implemented in HAW are still limited. In the Tropical Andes, there are 31 Ramsar sites covering 47480 km2, only 3.6% of the total area of lagoons are protected (Quenta et al., 2021). The conservation status of páramo and puna varies from critical to vulnerable (Bookbinder et al., 1995). For example, in Ecuador, wetlands cover an area of 286,659 ha, 86% of which are within the National System of Protected Areas (Jara et al., 2019). However, protected areas are not always large enough to cover regions that are relevant for conservation, such as watersheds, complete ecosystems, or integrated landscapes.

This document contributes to strengthening the capacities of people involved in wetland management, as well as civil society organizations, technical and academic staff. It emphasizes the understanding of the ecological role of these ecosystems and the implementation of good conservation and restoration practices with the objective of improving the management of HAW. The first section proposes general guidelines for evaluating and monitoring activities for the planning and implementation of conservation and restoration practices. Next, good conservation and restoration practices implemented in HAW are presented, grouped into six thematic areas. In the last section, the experiences of HAW management compiled from the countries where these ecosystems are present are detailed and, finally, conclusions obtained from this work are provided.

BASIC GUIDELINES FOR CONSERVATION AND RESTORATION IN HIGH ANDEAN WETLANDS

Conservation and restoration processes include planning, implementation and evaluation stages, for this reason it is necessary to consider some basic guidelines that support the projects to be undertaken. The following is a list of guidelines to be evaluated so that management can be assessed during all stages of conservation and restoration.

Self-Evaluation

Basic guidelines for conservation and restoration in high Andean wetlands

First stage

Knowledge of the study site	Evaluation		
	Adequate (2 pts)	Partial (1 pt)	Insufficient (0 pts)
Form multidisciplinary teams throughout the entire process.			
Understand the environmental reality with the different institutions and people of the territory.			
Compile existing monitoring information to know the current situation of the territory with the intention to work on conservation and restoration in an integrated management context, considering the complete situation of the territory and its surrounding areas in terms of its ecological, hydrological and social aspects.			
Knowing the history of the wetland, its effects and its natural potential in order to establish conservation and restoration strategies accordingly.			
Know the main causes of degradation in the affected wetlands, analyze direct impacts and upstream impacts.			
Know if there are reference ecosystems (relatively intact sites).			
Identify the most degraded wetland areas.			

Total score in the first stage:	

Second stage

Establishing conservation and restoration objectives.	Evaluation		
	Adequate (4 pts)	Partial (2 pts)	Insufficient(0 pts)
Establish clear, achievable and measurable objectives with indicators that allow monitoring of practices and their impacts.			
Prioritize the conservation of well-maintained but threatened wetlands: preserve and protect existing wetlands that are relatively intact to conserve biodiversity and ecosystem services.			
Choose a representative site where a pilot restoration plan can be carried out.			
Manage and monitor the process flexibly so that objectives can be restated and adjusted along the way.			

Total score in the second stage:	

Third stage

Planning the monitoring.	Evaluation		
	Adequate (2 pts)	Partial (1 pt)	Insufficient(0 pts)
Design a short - and long- term monitoring system.			
Consider data processing and information management.			
Consider at least one low-disturbance or non-intervention site as a "control site" in the design.			
Include monitoring of at least the following components:			
Site characteristics: baseline identification of wetland types along the altitudinal gradient, most and least wet areas, topographic survey, etc.			
Hydrology: Water table, quantity and quality of water feeding wetlands: natural and degraded concentrations.			
Biotic factors: vegetation mapping, biodiversity monitoring, fauna ecosystem services, vegetation physiological monitoring.			
Restoration techniques employed: indicators to monitor the practices employed (e.g. % conservation areas, coverage of restoration areas, increase in coverage), restoration monitoring			
Soil conditions: pH, organic matter and carbon content, soil bulk density, porosity, water holding capacity, electrical conductivity, etc.			

Total score in the third stage:	

Fourth stage

Planning practices for Conservation and Restoration.	Evaluation		
	Adequate (2 pts)	Partial (1 pt)	Insufficient(0 pts)
Identify conservation and restoration techniques to achieve the objectives, as well: anticipating future changes: consequences of the practices to be implemented (e.g. downstream).			
Anticipate the practices sustainability.			
Focus on restoring the physical and ecological integrity of wetlands.			
Use passive restoration where possible by reducing the causes of degradation and allowing the wetland to recover over time.			
Select native species for restoration.			
Prefer bioengineering techniques, natural infrastructure and nature-based solutions.			
Discuss planning with wetland experts, communities, and local politicians.			

Total score in the fourth stage:	

Fifth stage

Implementing the practices.	Evaluation		
	Adequate (4 pts)	Partial (2 pts)	Insufficient(0 pts)
Ensure that the practices implemented at the site correspond to planning.			
Rethink practices in cases where objectives are not being adequately met.			
Involve local voluntary organizations, communities, and other relevant institutions during the implementation, monitoring and long-term management process.			
Communicate and disseminate the project.			
Discuss monitoring practices with wetland experts.			

Total score in the fifth stage:	

Sixth stage

Evaluate the practices.	Evaluation		
	Adequate (4 pts)	Partial (2 pts)	Insufficient(0 pts)
Measure or estimate the results obtained in the conservation and recovery of wetlands in accordance with the objectives set.			
Determine the efficiency of the implemented practices versus the expected trend and impact.			
Evaluate and compare alternatives. Find possibilities for improvement and prioritization among them.			
Determine potential negative effects or trade-offs to identify possible safeguards.			
Systematize, document and communicate what has been learned in order to replicate, generalize and ensure the sustainability of the practices.			

Total score in the sixth stage:	

Evaluation

Adequate (75–100 pts)

Your practice considers all or most of the basic guidelines for conservation and restoration in high Andean wetlands to be applied correctly.

Partial (40–74 pts)

Your practice meets several of the basic guidelines. However, it needs reinforcement in those aspects with lower scores to obtain satisfactory results.

Insufficient (0–39 pts)

Your practice does not meet the basic guidelines for conservation and restoration in high Andean wetlands. Use the results of this self-assessment to identify improvements.

GOOD PRACTICES FOR THE CONSERVATION AND RESTORATION OF HIGH ANDEAN WETLANDS

TThe conservation and restoration of HAW is of great importance, as they are threatened by various anthropogenic factors; hence the importance of identifying practices that have been applied throughout the Andean region. The following is a set of good practices in conservation and restoration of HAW, grouped according to their common objective. These practices have been successfully implemented in these ecosystems and it is suggested to replicate them considering the established objectives and benefits in order to achieve their integrated management.

1. Social participation during the planning and implementation processes

Wetlands should be considered as socio-ecological systems, where communities, inhabitants and local institutions actively participate in the planning, decision-making, policy development, implementation of practices and monitoring processes. This participation is feasible through the provision of environmental education and adequate communication during all processes, allowing people to learn, identify and empower themselves with the problems and solutions proposed.

It is therefore necessary to first recognize the people and institutions that are acting in the site to be conserved or restored in order to consider most of the sectors involved. When there are agricultural interventions, as is the case in many HAW sites, rural producers make the decisions regarding ecosystems, since the main forms of land tenure and water use are communal (Castillo, 2006). In addition to the communities, governmental institutions that regulate ecosystem management decisions should be considered, as well as NGOs and international organizations that can promote social participation. Academia, especially with local knowledge, is of vital importance, as well as sectors that can provide funding. It is important to understand the visions of each participating sector and the interactions between them in order to coordinate common objectives.

To facilitate communication and participation, local communities and institutions must understand the state of the ecosystem and the benefits of conservation and restoration. Therefore, environmental education is key to promote social participation during all phases of the project. Education seeks, among other aspects, to promote a responsible culture regarding wetland conservation and restoration, strengthen the political action capacities of rural sectors, and adopt a learning approach through which those involved are able to learn and contribute knowledge and experiences (Castillo, 2006). Environmental education initiatives have been carried out in wetlands, for example, in the Department of Caldas in Colombia, where a plan on the conservation and management of HAW was directed to achieve the continuity of development and protection of these areas. Likewise, in Guatemala and Mexico, didactic materials such as workshops, videos and documents with easily digestible language for the communities were used (Ramsar Convention Secretariat, 2010). An interesting experience in environmental education is described in Experience 2 of this document, which describes the processes of training and elaboration of environmental education documents implemented in the State of Táchira in Venezuela.

Just as practical conservation and restoration interventions are important, so are social interventions conducted in parallel throughout the conservation and restoration process. With respect to social interventions, communication is key and people with different skills than those who usually implement practical interventions are needed. It is common in HAW to work with indigenous communities that have their own system of knowledge, perception of the relationship between humans and nature, cosmovision and language. It is therefore necessary to establish dialogues to achieve common objectives, allowing communities to share their knowledge and access interventions on a voluntary basis, understanding the direct benefits that these represent and clearly understanding their participation during the planning and implementation processes of practices. The mediation strategy is a concept that allows building communication channels between the sectors with less political power and greater management responsibility (rural sector) and those with greater political influence (government sector) (Castillo, 2005, 2006). Communication should allow conservation and restoration strategies to be built with the participation of all sectors and not with the imposition of biased practices from the academic and political spheres.

In the Rio Blanco watershed in Argentina, the creation of a protected area of HAW was carried out through the coordination of local and national stakeholders (communities, chambers of commerce, representatives of educational institutions, sports associations, representatives of independent local communities, and members of governmental and scientific sectors) who participated in the environmental assessment of the site's degradation factors, evaluation and mapping of ecosystem services, and design and formulation of the proposal for the creation of a natural protected area (Rubio et al., 2017). This study is a clear example of an appropriate combination of social participation and political action for the creation of HAW conservation areas using ecosystem-based management systems. Another example of successful social participation is detailed in this paper in the experience of the Rangel Association of Environmental Commissioners in Venezuela (Experience 4).

2. Policies for conservation and sustainable use

All countries in the Andean region are signatories of the Ramsar Convention, which proposes the participation of national and local governments, local communities, the productive sector, non-governmental organizations, academic institutions and international support for the achievement of sustainable wetland management (Ramsar Convention and EHAA Contact Group, 2008), which includes the planning and implementation of conservation and restoration practices. They are also part of several international agreements, for example, the Convention on Biological Diversity (PNUMA, 1992), which includes wetland biodiversity policies. Within each country where HAW exist, the government agents in charge of carrying out the objectives of the strategies agreed upon with these international entities are the corresponding Ministries in each country, such as the Ministries of Environment and Water. Likewise, given the importance of wetlands, several institutions have been created in the Andean region whose objectives are the conservation and restoration of HAW, for example, Grupo Páramo, Grupo para la Conservación de los Flamencos Altoandinos, FONAG, FONAPA, the national nodes of the network of high Andean wetlands RAMSAR together with the Ministries of the Environment in each country and Universities such as San Francisco de Quito and Pontificia Universidad Javeriana. It is important to create synergies between existing treaties in order to pursue common conservation and restoration objectives.

The most effective policy practice towards conservation has been to declare wetlands as protected areas. Additionally, within the framework of the Ramsar Convention, conservation and restoration plans for Ramsar sites have been developed. In countries where wetlands are state property, the declaration of protected areas is simpler; this is not the case in countries where the resources are concessioned, as this creates conflicts and the sustainable use of these wetland ecosystems becomes impossible to ensure (Ramsar Convention and EHAA Contact Group, 2008). It is important to have a comprehensive knowledge of the study site so that protected areas are not limited to small wetland areas, but consider the contributing watersheds and even the interdependencies of the ecosystems for an adequate delimitation of the area to be conserved (e.g., the puna in the central Andes is interconnected with glaciers, wetlands and forest patches). This document presents an experience on the proposal for the declaration of the wetlands of the Las González basin in Venezuela as a Ramsar site (Experience 3).

The policy strategy suggested by the Ramsar Convention for the implementation of conservation and restoration practices is to carry out coordination among the countries participating in the HAW strategy. Increasingly, Latin American countries are opting for community-based natural resource management. The participation of local governments and communities is positive as long as some aspects are taken into consideration. Funding from national governments must be sufficient for local efforts to implement sufficient conservation and restoration practices. In addition, local capacities and skills of local and technical personnel should be strengthened. The management of conflicts that occur between communities and local governments, especially when HAWs extend across provincial, national or international borders, requires the intervention of national governments and the implementation of policies with adequate communication between the sectors involved (Iñiguez Gallardo et al., 2013). The bottom-up approach and decentralization in environmental management are consistent with incentivizing communities and local governments, who make decisions about practices in HAWs, to be part of all processes towards wetland conservation and restoration. However, the challenges involved should be kept in mind, such as the various interests and possible conflicts when deciding on the management of ecosystems that are being degraded. An example of these potential conflicts arose in the páramo wetlands in southern Ecuador that cross four cantons. Local governments were proposing on the one hand the nationalization of a local protected area and, on the other hand, the construction of a road that threatened the conservation of the same wetland (Pinel et al., 2018). In this case, local governments maintained different interests and it was evident that decentralization led to conflicts without there being an entity in charge of managing them. National governments should have sufficient knowledge of the power relations and the reality experienced in each of the HAW areas to coordinate the management policies that can be applied to each case.

Payment for environmental services is a policy that can also contribute to the conservation of HAW by serving as an incentive and financing tool for communities and local governments in achieving sustainable resource use. There are experiences of payments for environmental services in protected areas in Latin America where watershed protection, the ecosystem service of carbon sequestration and fixation, as well as recreation and scenic beauty have been considered (FAO/OAPN, 2009). Some countries already have policies and regulations to deploy payment for environmental services, while others have implemented incentives, compensation and projects for local initiatives. However, this is still a developing issue but it could contribute to increasing conservation areas and improving the management of HAW that usually lack the economic means to implement sustainable practices.

Finally, it should be considered that the construction of policies should take advantage of research findings and link the scientific-academic sector. The dialogue of knowledges between academia, local, indigenous and peasant communities, and policy makers is fundamental to guarantee the development of evidence-based policies as well as ensuring their success and sustainability.

3. Hydrological restoration

In order to choose the appropriate practice(s) that will lead to the recovery of the water balance of a wetland, it is necessary to know the intervention site; that is, to study its hydrological characteristics and the stress factors that have caused or are causing a decrease in the quantity and regulation of water in the wetland. The most important aspects include the characterization of the climate, hydrology and interactions between the atmosphere, vegetation and soil. This step, although necessary, can be quite costly and requires a long period of time to develop a baseline as a reference of the initial state of the HAW to be intervened. An example of this effort is detailed in this document in the experience of Chirripó National Park in Costa Rica (Experience 1). An alternative to reduce the time required for the establishment of a baseline is to "exchange space for time" and simultaneously monitor a conserved or less intervened HAW of similar characteristics that is close by and serves as a reference for the HAW to be intervened.

The main objective of hydrological restoration is to recover the water table of the ecosystem to restore its storage capacity and hydrological regulation. Natural hydrological regulation allows water from rainy periods to be harnessed so that dry periods are less damaging and do not jeopardize the future functioning of the HAW (e.g. the water retaining characteristics of soils can be affected during extended periods of drought). The following practices have been implemented to restore the hydrology of HAWs:

- Ditch blocking: Ditches are very common in wetlands and constitute a severe problem as they cause water level lowering and wetland oxidation (Schimelpfenig et al., 2014). Blocking these ditches or backfilling them is a relatively simple practice that can be performed with natural material such as soil or vegetation from the wetland itself. This restoration practice was carried out in the Huascarán National Park wetland in Peru, where it managed to raise the water level to levels similar to those of nearby conserved wetlands, and it was also noted that the rate of carbon accumulation increased (Planas-Clarke et al., 2020). Other experiences of blocking and filling ditches are detailed in this document for the cases of the Chakana (Experience 6) and Pugllohuma (Experience 7) wetlands in Ecuador.

- Construction of dams: these are small structures in the form of steps across the flow of water located at the bottom of the degraded channel, with a height lower than the original base level of the system. The materials used for the construction of these dams must be suitable, preferably natural, such as logs or wood remains and soil or vegetation from the wetland itself. Structures of this type were implemented in the Laguna de los Pozuelos watershed in Argentina (Experience 9), achieving a longer water retention time in the system during the rainy season and partial impoundment of the river's scarce runoff during the dry season (Amaya et al., 2019).

These restoration techniques have a direct benefit by increasing the amount of water in wetlands and increasing their carbon sequestration capacity. This implies the improvement of ecosystem services and also contributes to climate change mitigation.

4. Soil recovery

Wetland soils are particularly sensitive to changes in hydrology induced by stream erosion, drainage construction, and prolonged drought. Soil degradation causes loss of wetland vegetation, increased runoff, reduced water infiltration into the soil, reduced productivity, among other impacts (Brandt & Townsend, 2006). Intensive livestock farming modifies the physical characteristics of the soil producing compaction, which is one of the most severe forms of soil degradation. Soil compaction has severe consequences on wetland hydrology, as it inhibits infiltration, decreases water availability, increases runoff and erosion (Harden, 2001; Valentin et al., 2005). All this leads to impacts on ecosystems and local communities. For example, local communities, experiencing a decrease in the availability or quality of water for their crops and other productive activities downstream, may deepen their dependence on livestock. This leads to increasing the number of animals and extending upstream grazing areas. Overgrazing, in turn, further decreases water storage and regulation capacity due to soil compaction in the HAW and nearby ecosystems, which further reduces water availability during low water periods. The resulting water stress forces communities to seek higher and higher grazing areas closer to water sources, deepening this dependence on cattle ranching, overgrazing and other unsustainable practices. This spiral of impoverishment and degradation must be broken and reversed through the restoration and conservation of the HAW, as well as the improvement and diversification of productive practices to avoid land occupation upstream and at water sources.

In HAW, soil recovery practices involve, in principle, the removal of the stressor and thus the cause of soil compaction, which allows the recovery of the soil's hydrophysical properties. This is known as "passive restoration" and is described in more detail in the next section. Other practices involve direct physical actions, such as the construction of erosion control structures. In the Department of Cochabamba in Bolivia, thousands of such structures were built that allowed short- and long-term evaluation of their performance. The structures mainly included the construction of small dams, terraces, tree planting and other structures in smaller quantities (Hartman et al., 2016). These structures are intended to reduce water velocity by increasing water retention, capture fine sediments, reduce runoff and erosion. Additionally, it is important to remember that land recovery techniques should be carried out in the areas of influence of wetlands. Consideration of landscape integrity is fundamental and the importance of watershed restoration as a whole should be emphasized.

Soil restoration leads to increased ecosystem services important to communities, such as the restoration of vegetation for sustainable grazing use. Water level elevation, as a consequence of the implementation of erosion control structures, strengthens water security, especially in semi-arid or arid areas, contributes to groundwater recharge and stability of water flows in downstream areas (Hartman et al., 2016). In addition, soil restoration contributes to climate change mitigation by regenerating the soil's capacity to sequester carbon and to be a carbon sink, rather than a carbon emitter. It is important to link restoration to the enhancement of ecosystem services, to ensure that communities have an interest in maintaining sustainable management of HAWs in the long term.

5. Passive and active vegetation restoration

Passive restoration consists of eliminating the disturbance or disturbances that are affecting the wetland, such as intensive agriculture, grazing, and intentional burning. Controlling these stressors on the ecosystem allows the vegetation to regenerate on its own. Although it is a practice that has economic and technical advantages compared to active vegetation restoration, it should be carried out when the damage to the wetland is low, resilience is high and there is sufficient time to obtain results (Aguirre et al., 2013). Adequate monitoring is necessary to ensure that recovery is optimal, as species invasion can occur. In addition, the records generated by a monitoring system will allow knowing the successional changes until reaching a vegetation typical of saturated zones.

Passive vegetation restoration can also be useful during the elaboration of pilot vegetation restoration plans, since this practice can be considered as a comparative reference with active restoration. In a frailejones páramo site located in Carchi in northern Ecuador, active restoration practices (introducing native species) were compared with passive restoration, and it was found that the success of the practices depends on the slope of the terrain, due to the availability of water and the characteristics of the vegetation (Rodríguez-Echeverry & Leiton, 2020). Therefore, in new sites where there is no previous information, it is necessary to carry out pilot plans in order to determine the best restoration practices and the most appropriate vegetation species, before applying them on larger scales (Rodríguez-Echeverry & Leiton, 2020).

Active restoration involves the introduction of vegetation into disturbed wetlands or surrounding areas. This restoration must necessarily involve the use of native species that provide functional diversity to the recovering ecosystem, so that the long-term results are adequate. In Lake Junín in Peru, active restoration of vegetation was carried out through transplanting of vegetative cores, cuttings and direct seeding (Amaya et al., 2019). The transplanting of cores consisted of implanting wetland vegetation cores in the bare soil, preferably during rainy seasons to ensure a high moisture content in the soil. The transplanting of cuttings or seedlings was carried out in fenced areas to protect them from livestock. Direct sowing of seeds allowed a greater coverage of the area and a better plant composition; however, the survival of the species in this study is unknown, although it this type of practice of sowing seeds is usually lower than restoring with seedlings, nuclei or saplings. Two experiences of sowing and transplanting plants in wetlands are detailed in this document in the La Vaca wetland in Colombia (Experience 5) and in Punchaucocha in Peru (Experience 8).

In páramo areas, active restoration has been successful. This is important because these areas are water recharge areas for wetlands. In the case of páramos, restoration has been carried out by introducing pajonal seedlings, planting shrubs and transplanting weed mats. This type of practice forms restoration nuclei that give way to greater diversity, transporting plants, seeds and mosses and maintaining a permanent source of seeds that attract fauna that consume, disperse and disseminate the seeds (Aguirre et al., 2013). It should also be taken into account that, in sites with a steep incline, wind can limit the survival of plants, so it is recommended to introduce seedlings with vegetation around them, avoiding bare soil, for example, by introducing additional plant material (e.g. mulch). This allows maintaining moisture in the soil around the vegetation (Aguirre et al., 2013). Another alternative to prevent erosion in bare soil and slopes is the application of a layer or biomant, constructed from a biotextile (jute, fique or any other natural fiber) (Aguirre et al., 2013). Considering these practices ensures a high survival of the vegetation compared to the introduction of seeds. These strategies are effective in areas with slow regeneration processes due to low net primary productivity, low temperatures, high day-night temperature variations, and acid soils, as occurs in the high tropical mountains (Rojas Zamora, 2013). In addition, these practices are recommended in degraded areas, especially in areas degraded by cattle ranching (Insuasty et al., 2011).

6. Habitat improvement

The restoration of the HAA through the application of practices that allow the recovery of soils and hydrology also results in the recovery of the ecosystem's flora and fauna. Likewise, in some areas degraded by erosion, burning, and extraction of vegetation cover, natural revegetation occurs over time. However, additional practices can be employed, as species in specific degraded and bare soil areas are not rehabilitated unless habitat conditions are improved (Schumann et al., 2008). This includes eliminating pressures exerted by humans, animals, and fires, among other stressors (Schumann et al., 2008).

An important habitat improvement practice is the management and control of livestock. It is common to find overgrazing in HAW areas with replacement of native animals, which causes soil compaction, erosion, and, consequently, water loss (Amaya et al., 2019). Therefore, it is necessary to reach sustainable livestock agreements that consider the production needs of local communities and the ecosystem benefits of conservation and restoration. Analyzing the carrying capacity of the study site contributes to the correct elaboration and implementation of a grazing management plan. To calculate carrying capacity or receptivity in the wetlands of Lake Junín in Peru and Laguna de los Pozuelos in Argentina, the net primary productivity method was used (Golluscio et al., 2009) in order to establish the adequate livestock load that would support the wetland without degradation (Amaya et al., 2019). This allows identifying and implementing the wetland areas that should be fenced to avoid grazing, the areas in which grazing can be allowed, the duration of grazing, and the rotation of the load; all this to avoid overgrazing and allow the natural recovery of the vegetation. If possible, it is advisable to replace non-native livestock with native livestock (e.g. cattle with llamas; Amaya et al. (2019)). In a similar experience in the high Andean pastures of Ishinca in Peru, exclusion zones were constructed at low elevations, where grazing was allowed only within them, reducing grazing regions (Byers, 2010). In addition, the suspension of annual pasture burning practices allows soil recovery. After these measures, the proportion of bare soil was reduced and replaced by grasslands and natural vegetation. In addition, water was stored in greater quantities in the area, demonstrating the high resilience of the HAW in the area and the effectiveness of the practices implemented. Likewise, in the Jatunhuaycu grassland site located in the Antisana water conservation area in Ecuador, barbed fences were constructed surrounding the ecological restoration pilot projects with the objective of protecting the restoration practices by preventing the entry of livestock from neighboring private landowners into the area. This paper details the removal of grazing in Chakana in Ecuador (6) and livestock management in Argentina (9).

Another habitat improvement practice is the recovery of fauna in degraded HAW sites. In degraded páramo areas, for example, the presence of shrubs decreases and small mammals lose their habitat; therefore, the construction of shelters using shrubs and logs from the area allows the recovery of mammal habitat (Aguirre & Torres, 2013). In addition, the construction of artificial perches for birds allows their displacement, and with this, bird droppings contribute to the dispersion of seeds that help revegetation and soil enrichment, in addition to increasing the fauna of the páramo. This document details the recovery of flora and fauna of the La Vaca wetland in Colombia (Experience 5).

EXPERIENCES IN HIGH ANDEAN ECOSYSTEM CONSERVATION AND RESTORATION

This section shows a scope of the RAMSAR High Andean Wetlands Strategic Action Plan (Ramsar Convention and EHAA Contact Group, 2008) in each country. The objectives of the Plan include environmental education, creation of local associations for wetland management, proposals for conservation site declarations, conservation and restoration practices, among others; therefore, the subject matter of the experiences is varied.

COSTA RICA

1. Hydrological characterization of Chirripó National Park

Turberas de Talamanca

- Stakeholders Involved

  Park Rangers, Local community, Academics.

- Authors/ Institution

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Chirripó National Park, La Amistad-Pacífico Conservation Area, National Conservation Area System

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Description of the experience

The Páramo is a mountain ecosystem located between 11°N and 8°S, in the upper mountainous region above 3000 m a.s.l., and below the permanent snow line at about 5000 m a.s.l. The vegetation is characterized by tundra-like foliage consisting of grasses, small herbs and shrubs. In Costa Rica, the páramo is confined mainly to the Talamanca mountain range, where in 1975, the Costa Rican government created the Chirripó National Park, resulting in the protection of ~10 000 ha of this fragile ecosystem in an elevation range of 3000-3820 m asl.

The páramo of Chirripó National Park is also characterized by the presence of glacial landforms, including nearly 30 glacial lakes. These lakes can be considered sentinels of climate and ecosystem change because they preserve evidence of past changes in climate and environment due to natural processes and anthropogenic activities.

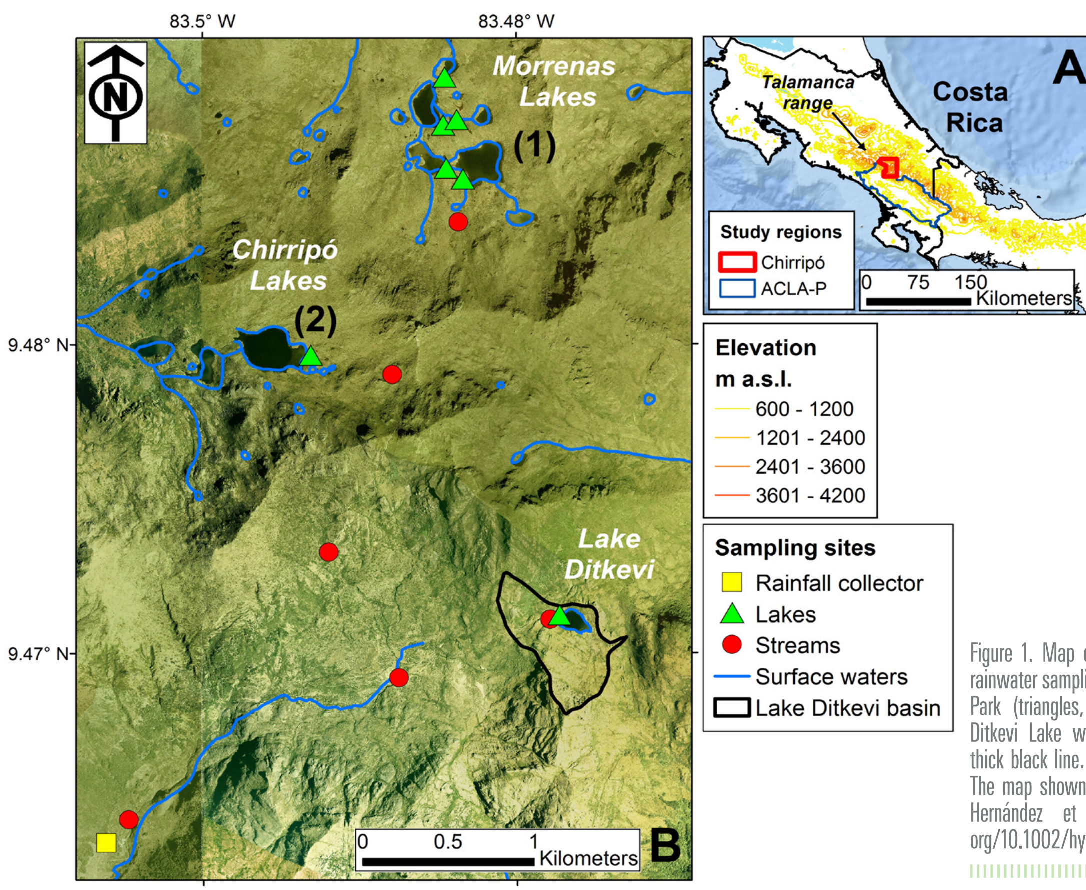
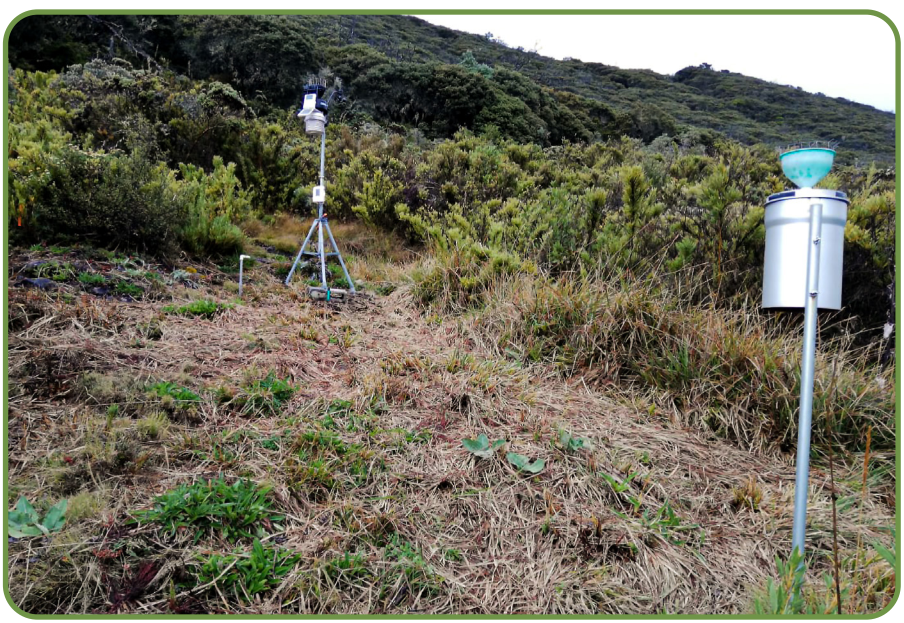


Figure 1. Map depicting surface water and rainwater sampling points in Chirripó National Park (triangles, circles and squares). The Ditkevi Lake watershed is also shown in thick black line. Streams are shown in blue. The map shown was published in Esquivel-Hernández et al., 2018. (https://doi.org/10.1002/hyp.13286).

Since 2015, a hydrological characterization of the conditions of Páramo de Chirripó has been developed, which includes the recording of meteorological conditions, sampling and analysis of rainfall samples, streams, springs and lake water. The main tool used to interpret the information obtained is the use of stable isotopes..

Because Chirripó National Park is located in a remote area, and it is not possible to conduct field work as often as desired, the park rangers have been essential for the development of the project, as they have been responsible for the collection of daily rainfall samples, weekly surface water samples (springs, streams and lakes) and, during the 2015-2018 period, the daily recording of weather conditions in Chirripó. In early 2019, the installation of an automatic weather station meant progress in the recording of weather conditions in this páramo. Additionally, the transportation or hauling services provided by the surrounding communities have been essential for the development of the biannual sampling tours and for the transportation of the samples collected by the park rangers. This effort has involved the generation of a database with more than 500 rainwater samples and 350 surface water samples, in addition to a continuous record of precipitation, relative humidity and temperature from April 2015 to date. There are also soil temperature records and a bathymetric map for one of the glacial lakes. Attached are photographs of the work carried out in Chirripó.



Photograph: Automatic weather station (in the background) and the rainwater sample collector for isotopic analysis (in the front).

Achievements, Effects and Impacts

The research project developed in Chirripó has advanced our understanding of the role of tropical biomes such as the Central American páramo in the global water cycle and will help establish baseline information relevant to the analysis of future climate change scenarios. In addition, the research at Chirripó has provided opportunities for the training of park rangers and other local stakeholders through participation in field work. This training and participation of park rangers has focused on performing basic experimental work (e.g., they have participated in rainfall and surface water sampling), but theoretical training has also been provided through online lectures to encourage their participation in the research project. Community members are also involved in the projects through their participation in workshops to disseminate results.

Photograph: Measurement of pH, temperature and electrical conductivity in the surface water systems of Páramo de Chirripó.

What made the success of this experience possible

The collaborative nature of this research leverages the intellectual and analytical resources of an academic institution and the government's expertise in conservation and management of tropical ecosystems. This collaborative approach is particularly relevant to the research at Chirripó because of the logistical constraints inherent in conducting complex biogeochemical measurements in isolated ecosystems. Therefore, the project leverages the expertise of team members to analyze the data and generate relevant conclusions that help achieve the common goal of improving our understanding of the water cycle and the state of its conservation in the Páramo.

Lessons Learned

The lessons learned from this Project are:

- The possibility of conducting high-level research jointly between government agencies and academic institutions.
- The need for training and involvement of officials in charge of safeguarding protected areas, such as park rangers.
- The importance of committing to medium to long-term research, vital to improve the understanding of the climatic and hydrological conditions that control the water cycle in remote mountain systems such as the Central American Páramo.

Sustainability Perspectives

Special care has been taken to ensure that the experimental work complies with the following conditions: i) Collection of rainwater and surface water samples has been carried out only by park rangers or academics involved in the project, ii) Samples collected are of a very small volume (~30 mL) and do not impact the water systems. Other measurements also have no impact on the ecosystem in question and iii) Field trips are conducted only twice a year and in areas with easy access, in order to minimize disturbance to the vegetation and surface water system.

REPÚBLICA BOLIVARIANA DE VENEZUELA

2. Environmental education for the sustainable development of the high Andean wetlands of the State of Táchira, Venezuela

Lagoon system of the General Juan Pablo Peñaloza National Park in the Páramos del Batallón and La Negra, in the Táchira sector of the Bolivarian Republic of Venezuela.

- Stakeholders Involved

Schools nearby the lagoon system.

- Authors/ Institution

EcoHumana Foundation
Universidad Pedagógica Experimental Libertador (UPEL)
Simón Bolívar Univeristy (USB)
University of Carabobo (UC)
National Parks Institute (INPARQUES)
Ramsar Convention Secretariat (Proyecto No. WFF/07/VE/01)

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Description of the experience

The experience was developed between 2008 and 2009 thanks to the financial support of the Wetlands for the Future Fund. The objective of the project was to promote environmental education for the sustainable development of the HAW of the state of Táchira, through a program geared toward the educational sphere. This was done through the training of higher education students and teachers from school communities located in and around the General Juan Pablo Peñaloza National Park in the Páramos del Batallón and La Negra, and the production of printed educational materials.

The project consisted of four components:

(1) Development of pedagogical models of integration; (2) Training of higher education students; (3) Training of teachers related to the protected area; and (4) Production of didactic materials for these teachers.

The results of each phase are summarized as follows:

1. 1. The fourth, fifth and sixth grade programs of the Bolivarian Primary School Subsystem were analyzed and two (2) integration schemes were developed: one referring to the HAW in general, and the other referring to the General Juan Pablo Peñaloza National Park in the Páramos del Batallón and La Negra as an area that protects the HAW.

2. 20 students from the biology, rural, preschool, computer science and integral education programs of the Universidad Pedagógica Experimental Libertador (UPEL) were trained at the Pedagogical Institutes of Caracas and Gervasio Rubio. In the course entitled "Environmental Education for the sustainability of Venezuela's high Andean wetlands", the students gathered base information about the area and studied the previous ideas of teachers and students about the HAW. Subsequently, the trained students began the elaboration of didactic units and participated as co-facilitators in the teacher training workshop.

3. The training of teachers began with an induction workshop and basic information on wetlands, followed by a series of follow-up meetings in the schools to promote the incorporation of this topic in the curriculae.

Finally, two Environmental Didactic Units (UDA) were elaborated: one on the National Park (A*siento de humedales altoandinos*) and the other on the HAW of Táchira State (*Humedales en las alturas*), which contain didactic strategies to approach the topic in the classroom.

Achievements, Effects and Impacts

The sustainability of high Andean wetlands as an integrating theme of the National Basic Curriculum and the Bolivarian Educational System

The educational intervention carried out through the development of Environmental Didactic Units (UDAs) and Learning Projects (PAs), both in higher education and in basic education, generated an increase in the knowledge and appreciation of these ecosystems in the communities addressed. The development of these planning strategies favored the incorporation of wetlands as an integrating theme in Venezuelan Basic Education, and the project has yet to be continued in other Venezuelan wetlands.

Training of Higher Education Students

Twenty students from the biology, rural, preschool, computer science and integral education majors of the Universidad Pedagógica Experimental Libertador were trained at its Caracas and Gervasio Rubio Pedagogical Institutes. In the course entitled "Environmental Education for the sustainability of the high Andean wetlands of Venezuela", the students gathered basic information about the area, studied the previous ideas of teachers and students about the high Andean wetlands. Subsequently, the trained students created didactic units and participated as co-facilitators in the teacher training workshop.

As an impact of this activity, it is interesting to note that the course was incorporated into the curriculum of the Sub-Program of the Master's Degree in Environmental Education of the Pedagogical Institute of Caracas (UPEL). The course continued to be taught to support other wetlands.

Training of teachers from schools near the high Andean wetlands and their learning projects

25 classroom teachers were trained in topics related to the knowledge and appreciation of high Andean wetlands and the development of educational projects on this topic. The commitments assumed by the teachers led to the production of educational projects that were adapted to the National Basic Curriculum and the Bolivarian Educational System. During the follow-up and monitoring process, teachers showed continued interest in the theme, which ensures a level of motivation and commitment to continue developing this topic in future school periods.

Didactic Units as proposals for classroom work

The two Environmental Didactic Units (UDA) published in 2009 were a contribution to the use of these planning strategies in the classroom. In their design, the incorporation of diverse didactic strategies was considered in order to consolidate and make more effective the teaching praxis in any subject to be addressed, in particular those related to the use of the environment as a resource and end of the teaching and learning process.

Dissemination of the experience

The experience, created to promote Environmental Education for the Sustainable Development of the high Andean wetlands of Táchira state, was disseminated through the publication of an article in the UPEL journal Aula y Ambiente (Vol.10, No.19, 2010) called "Environmental Education in high Andean wetlands of Táchira state, Venezuela: An experience in higher education and teacher training" (Available at https://issuu.com/revistaaulayambiente/docs/aula_y_ambiente_-_n19), as well as its presentation during the 5WEEC (World Environmental Education Congress, Montreal, Canada, May

10-14, 2009) with the paper "Environmental Education for the sustainability of high Andean wetlands: experience in Venezuelan higher education" (Congress Link: https://weecnetwork.org/congresses/5weec/).

Credits: José Moncada

Photograph: Laguna Verde del Páramo del Batallón, Táchira state, with the group of trained teachers. General Juan Pablo Peñaloza National Park in the Páramo del Batallón and La Negra.

What made the success of this experience possible

- FHF Financial Support (Project No. WFF/07/VE/01)
- Consolidation of a working team between the NGO, the three universities and the National Parks Institute (INPARQUES).
- Personal commitment of the researchers.

Lessons Learned

The importance of follow-up and monitoring of teacher training processes.

Sustainability Perspectives

- The project was conducted between 2008 and 2009, and the work was not given a follow-up in the long term because the group of universities worked in other Venezuelan wetlands.
- It is not known if the governmental actors responsible for the protected area continued with the work undertaken.
- During the follow-up and monitoring process, teachers showed a continuous interest in the subject, which should ensure a level of motivation and commitment to continue developing this subject in future school periods.
- The course was incorporated into the curriculum of the Sub-Program of the Master's Program in Environmental Education of the Pedagogical Institute of Caracas (UPEL). The course continued to support other wetlands.
- This process was replicated until 2012 in other areas with non-high Andean wetlands, associated with the states of Guárico, Falcón and Zulia.

3. Proposal for the declaration of the wetland system of the upper basin of the Las González river (Venezuela) as a Ramsar site

Las Gonzalez River Upper Basin Wetlands System, Mérida State, Bolivarian Republic of Venezuela

- Stakeholders Involved

National Parks Division, Mérida Regional Directorate of the National Parks Institute (INPARQUES).
Coordination of the Sierra de La Culata National Park.
Biodiversity Unit of the Territorial Unit of Ecosocialism (UTEC) - Mérida (Ministry of People's Power for Ecosocialism - MINEC).

- Authors/ Institution

Ing. For. Román Gerardo Pineda (INPARQUES)
TSU Héctor Prieto (MINEC)

- Contact

José Moncada. E-mail: moncadarangel@yahoo.es

Description of the experience

High Andean wetlands are strategic ecosystems not only in the ecological aspect, but also play an important economic, social and cultural role in the communities whose dynamics are developed in the areas of immediate influence and even in the most remote areas, as they contain water reservoirs, essential for life and for the development of these communities. They also have a unique biological diversity, with many plant and animal species not found anywhere else and several species of migratory birds that congregate there temporarily. They include lakes, lagoons, peatlands, pastures, rivers, streams, and other water bodies defined as wetlands in the Ramsar Convention, including their catchment basins, which are found in the Andes Mountains and other mountain ecosystems in Latin America.

In Venezuela, most wetlands are found within protected areas, especially in National Parks and Wildlife Refuges and Reserves, as is the case with High Andean Wetlands. These wetlands are found in the páramos and are not isolated bodies of water, but rather systems or complexes that are essential for the dynamics of the microbasins in the high mountains and other hydrographic systems. High Andean wetlands are considered by the Ramsar Convention to be highly fragile ecosystems with vulnerability to factors such as climate change, prolonged droughts, and human intervention.

In 2006, work began uninterruptedly for more than three years in the region, with the participation of technical personnel from INPARQUES and the current UTEC Mérida of MINEC. During this period, the Mérida State Wetlands Committee was formed, the implementation of the Regional Strategy for High Andean Wetlands was carried out, the Wetlands Inventory Project was formulated and began to be executed, the information required in the Ramsar Information Sheets to propose new sites was recorded, and the socialization of the proposals was scheduled. Meetings were held in the communities of the Upper Chama River Basin and in the community of Cañada de Las González, located within the proposed Ramsar Site of the Upper Las González River Basin Wetland System.

For the moment, two proposals have been prepared. They have partially completed the initial stages that allow them to be included in the List of Wetlands of International Importance, and would become the first in this category in the country.

Particularly advanced is the proposal for the Las González River Upper Basin Wetland System. Here the community of Páramo de Los Conejos or Cañada de Las González is located, a traditional Andean community made up of families dedicated to agriculture, especially the production of potatoes and to a lesser degree some vegetables for self-consumption, with low-scale, extensive cattle raising, and the collection of ethnobotanical species. Some of the inhabitants are dedicated to providing tourism services, a socioeconomic activity for which this area has great potential due to its relevance and unique landscape and culture; however, due to the pandemic that began in 2020, tourism has practically disappeared or has been reduced to the bare minimum.

The environmental benefits (water availability) of the area make it necessary and urgent to establish programs and projects within the framework of sustainable rural development and mitigation of negative environmental impacts, with the active and leading participation of local communities, in order to ensure its sustainability over time.

During the last five years, an interinstitutional team was formed by personnel from the Mérida Regional Directorate of the National Parks Institute and the Biological Diversity Unit of UTEC - Mérida to evaluate the wetlands located in the upper basin of the Las González River (Sierra de La Culata National Park) due to their strategic importance for the environmental services derived from their conservation, especially with regard to the water supply for the aqueducts that supply the towns of Lagunillas and San Juan in the Sucre municipality of Mérida State and numerous rural communities in the Campo Elías municipality. This team was made up of personnel from the National Parks Division and Coordination of Sierra de la Culata National Park, the Mérida Regional Directorate of INPARQUES, and the Biological Diversity Unit of the UTEC - Mérida (MINEC).

Credits: Adriana Morales.

Photograph: Las Gonzalez River, Campanario Peak in the background (4.300 asl), Mérida state.

Achievements, Effects and Impacts

Among the activities carried out by the team for the evaluation and update of the proposal for the declaration of the Las González River Upper Basin Wetland System as a Ramsar Site, were the following:

- Meetings with the community of Cañada de Las González to inform about the project.
- Visits to the study site to:

  1. Carry out the inventory of wetlands in the upper basin of the Las González river (the templates for the collection of information were designed and tested to evaluate their effectiveness in the field).
  2. Assess the conservation status of the inventoried wetlands (designing templates).
  3. Evaluate the boundaries of the proposed Ramsar Site.

With this field information, a new map of the proposed Ramsar Site was drawn up, expanding the area in relation to the 2007 proposal, and finally, the Ramsar Information Sheet was filled out in electronic format (update).

What made the success of this experience possible?

The work carried out met the proposed objectives since it allowed for a partial reformulation of the Ramsar Site proposal initially prepared in 2007, particularly in terms of surface area; it also allowed for a more detailed understanding of the conformation of the wetlands in the site and their functional relationships, their ecological benefits and the main problems that have been affecting them.

Lessons Learned

Among the most successful factors contributing to the experience was the integration of an inter-institutional team for the gathering of information, and the participation of community members, who showed high expectations in relation to the proposal for the Ramsar Site declaration.

Sustainability Perspectives

The promotion of sustainable activities in the area requires the development of an action plan that, after identifying the current situation of the area, the problems it presents, and the identification of clear and precise objectives, allows the formulation and development of activities that not only generate positive actions on the wetlands present here, but also provide economic benefits to the community, always taking into account the conservation of water resources and the biological diversity of the area as fundamental aspects of it. In this sense, an active participation of the community is necessary in the identification of action strategies that can be promoted from within the community.

4. Conservation actions carried out by the Association of Commissioners of the Environment of Rangel - ACAR (Venezuela)

Headwaters of the watercourses that make up the Upper Chama River Basin in the state of Mérida, Bolivarian Republic of Venezuela.

- Stakeholders Involved

  Association of Commissioners of the Environment of Rangel (ACAR) - Guardianes del Páramo.

- Authors / Institution

  ACAR Coordination : MRS. Ligia Parra Albarran. 3,000 farmers in 48 Irrigation Committees of the Rangel Municipality in the state of Mérida. Sowers of Hope Ecological Group (Simón Rodríguez University). Communal Councils Rangel Municipality, Mérida state. 48 Environmental Commissaries, 1 for each Irrigation Committee. Grassroots organizations within the team:
  ASESALUD (Community Health Counseling and all-organic home gardens)
  CONAPLAMET (National Medicinal Plants Commission)
  PROINPA (Integral producers of the páramo)
  MUCURATIVAS (Medicinal Plants Cooperative)
  Lic. Nocturno Carrera TC. MED. en Agroecologia
  Flia. Parra Albarran, Comunidad Misinta.

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  General Coordinator: Sra. Ligia Parra, Tlf. 0414-7469543
  Dr. Michelle Delen / Telf. 0414-7463846
  Lic. Nidia Parra / Tlf. 0426-8344430

Description of the experience

ACAR is the acronym of the Association of Environmental Commissioners of Rangel, in the state of Mérida in the Bolivarian Republic of Venezuela. It is a non-profit, non-partisan, non-religious, socially based association.

Its mission is to care for and protect the headwaters of the watercourses that make up the Upper Chama River Basin and the environment in general in order to achieve a better quality of life for the inhabitants of the Rangel Municipality and the communities downstream within a sustainable development scheme.

Photograph: Initial state of the site where the "water sowing" process was carried out (Asociación de Comisarios del Ambiente de Rangel - ACAR, Guardianes del Páramo, local Community Councils and Irrigation Committees).

On the other hand, ACAR's vision is compromised with environmental management and development, representative and defender of the individual and collective environmental rights of the human conglomerate that relies on the Municipality; sustained in the community participation and in the enhancement of the ancestral knowledge linked to the technological innovation. Its success is due to the participation of the communities of the Rangel Municipality in each of the activities planned within the organization. Its slogan: Love, Union, Peace and Work... To love and respect our mother nature, is everyone's duty and conscience.

Photograph: Subsequent state of the site where the "water sowing" process was carried out (Asociación de Comisarios del Ambiente de Rangel - ACAR, Guardianes del Páramo, local Community Councils and Irrigation Committees).

The headwaters of the watercourses that make up the Upper Chama River Basin, and the watercourses themselves, are subjected to different types of pressures, including a large volume of garbage that is irresponsibly dumped on the land and roads, and thus the survival of the frailejones and wetlands, unique species in the world that only exist in our Mérida páramo, is in danger.

Among the most affected areas, according to Parra, are the upper part of Pico El Collado del Cóndor (formerly Pico El Águila), areas of Laguna de Los Guaches, the road to Piñango, Laguna La Victoria, Cardenal Quintero municipality and the road that leads to the town of Chachopo, since the merchants and residents, due to the lack of solid waste collection by Urban Sanitation, dispose of their garbage at these places. In addition to the above, there are also problems due to the garbage thrown by tourists.

This situation prompted a group of residents of Mucuchíes, concerned about the deterioration of the environment, to form the Association of Environmental Commissioners of Rangel (ACAR) and who call themselves Guardians of the páramo, whose purpose is to value the landscape, water, frailejón, flora and fauna, which is being affected by large amounts of garbage discarded by people from the municipality of Rangel, neighbors from other communities, merchants and tourists.

The group, coordinated by Ligia Parra, has the support of Elpidio Dávila, Nidia Parra, Javilea Espinoza, Ana Villarreal, Tomás Zerpa, the Mayor's Office of Rangel, the Municipal Council, the Environmental Guard, Universidad Nacional Experimental Simón Rodríguez, the National Parks Institute (INPARQUES), the Ministry of Popular Power for Ecosocialism (MINEC), Superior Agrarian Court, Irrigation Committees and the communities of La Granja, El Mocao, El Pueblito, La Asomada and Musui, as well as media outlets such as radio stations Ondas del Páramo and CDR 98. 7 FM; the news portal Mérida Digital, and the newspapers Frontera and Pico Bolívar.

In addition, the Posada Pie Grande, the Liceo Nocturno Mucuchíes and Ciudamile of the Universidad de Los Andes provided valuable support for the group.

Credits: ACAR.

Photograph: Future environmentalists in the headwaters of the watercourses that make up the upper basin of the Chama River in the state of Mérida (Association of Environmental Commissioners of Rangel - ACAR, Guardians of the páramo, local Community Councils and Irrigation Committees).

Credits: ACAR.

Photograph: Teaching love and respect for nature in the upper basin of the Chama River, Mérida State (Association of Environmental Commissioners of Rangel - ACAR, Guardians of the páramo, local Community Councils and Irrigation Committees).

Achievements, effects and impacts

- Beneficiaries:
  Direct: 3007 farmers
  Families: 11.200
  People: 22.200
  Indirect: Barinas, Trujillo y Zulia
- Integration of all the producers of the Municipality of Rangel in the work of ACAR.
- 8 Irrigation Committees and Community Councils (with more in the process of being set up)
- Schools incorporated into the program, special supports.

- High Schools
- National Universities (ULA, UNESUR, UNELLEZ, LUZ, Simón Rodríguez, Bolivariana)
- International Universities (Tübingen – Germany and Netherlands)
- Awarded the Proyecto Páramo Andino First Prize in Ecuador in 2009
- Interest of several towns and neighboring states in replicating the work done in the Municipality of Rangel
- Generation of employment for graduates of the nocturnal high school career: AGROECOLOGY (Talks, education and orientation directed at primary and secondary schools about love and respect for mother nature, taught by students who are going to graduate).

What made the success of this experience possible

- Community willingness and people's participation.

Lessons Learned

- The importance of valuing the contributions of community members and the organizational power of the social base.

Sustainability Perspectives

- Its sustainability is ensured by the fact that it has remained within the control of the Association of Environmental Commissioners of Rangel (ACAR) - Guardians of the Páramo, Community Councils and Irrigation Committees.


COLOMBIA

5. Ecological recovery of the La Vaca Wetland District Ecological Park (Colombia)

Complex of Urban Wetlands of the Capital District of Bogota, consisting of 11 District Ecological Wetland Parks.

Specific Case: La Vaca Wetland District Ecological Park

- Stakeholders Involved

  Kennedy Community, Seed Bank, Guardians of the Water, Social Group Foundation, Catasix.

- Authors/ Institution

  District Secretary of the Environment of Bogotá (SDA), Bogota Water and Sewage Company E.S.P. (EAAB E.S.P.), Local Mayor's Office of Kennedy and surrounding communities.

- Contact

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Description of the experience

The wetland of La Vaca (North), declared as a Wetland District Ecological Park (WDEP) in 2004 by Decree 190 (Land Management Plan) is located south-west of the city of Bogotá, and belongs to the Kennedy District. This ecosystem, as well as ten other wetlands in the city, were designated as part of the Urban Wetlands Complex of the Capital District of Bogotá to be included in the Ramsar list of Wetlands of International Importance (Figure 1). The legal area of the La Vaca (North) WDEP is 5.7 hectares, and is located between Avenida Dagoberto Mejía and Carrera 91 Sur; between the south side of the Corabastos enclosure and Calle 41 Bis A Sur.

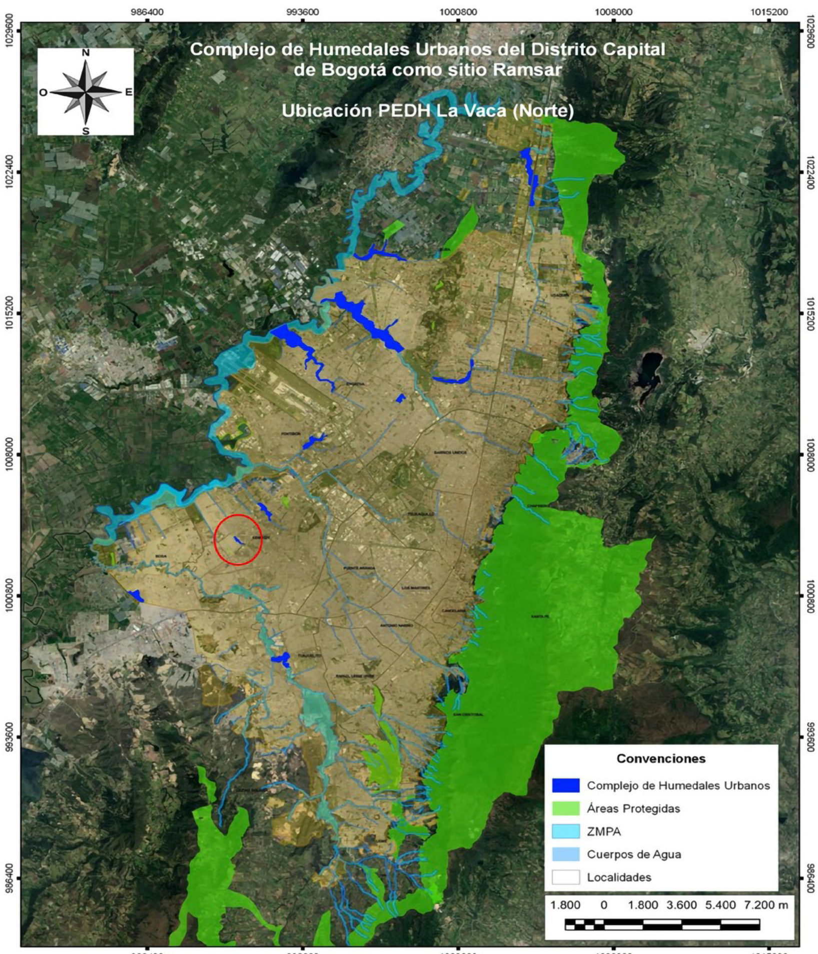

Figure 1. Geographical location of La Vaca (North) WDEP (framed in a red circle) which is part of the Urban Wetlands Complex of the Capital District of Bogota as a Ramsar site. Source: SDA, 2021.

Since the late 1980s and early 1990s, the wetlands in the southwest of Bogotá D.C. and, in this case, La Vaca (North) WDEP, suffered from water pollution and loss of flood areas. The low quality of the water and the erroneous connections of sewage or industrial waters led to the deterioration of the biodiversity and some of the functions of La Vaca WDEP.

Urban development is considered the main cause of the loss of wetland areas, a phenomenon correlated with the migration of farmers to the city. With population growth, the demand for housing increases, driving unplanned urban development to the detriment of the wetlands, in addition to the low capacity of the local government at the time to manage this situation.

The process of informal urbanization, without planning, promoted the division and sale of the old haciendas of La Sabana for the construction of housing, known as “loteo”. This process resulted in the drying up of water bodies with the disposal of debris and garbage, systemically eliminating the wetlands in the area.

Ignorance about the composition, function and value of wetlands, coupled with negative perceptions of them as unhealthy, smelly, dangerous or lacking in development, were common in the imagination of the city’s inhabitants and authorities until the early 1990s. This is the context in which the fourteen neighborhoods that make up the area of influence of the wetland were consolidated during this period. The inhabitants of these neighborhoods initiated organizational processes such as, for example, the Sector Committee to improve the conditions of their homes, access to electricity, water and sewage services, road improvement and, in general, for the legal recognition of their neighborhoods and the titling of their land.

However, with Agreement 9 of 1990, the Bogotá D.C. Council created the Technical Administrative Department of the Environment (DAMA), and with Agreement 02 of 1993 prohibited the draining or filling of existing lagoons and swamps and delegated the EAAB to define these areas. In 1994 the Bogotá Council issued Agreement 19, which declared wetlands as natural environmental reserves of public interest and ecological heritage of the city, and issued provisions for the EAAB to carry out the demarcation of wetland bodies, including the WDEP La Vaca (North). This declaration generated a conflict between the interests of the local inhabitants (with their demands for guarantees of rights to housing, household services, accessibility and ownership of their properties), and the collective rights to enjoy a healthy environment with the conservation of wetlands.

Based on the interest of the city government and the local citizenry to reach an agreement, and by way of collective citizens' assemblies and the formation of working groups, it was agreed to prepare a technical study that establishes the viability of recovery of these wetland ecosystems in the town. One of the conclusions of this study was the need to redefine the area of the La Vaca (North) WDEP and focus efforts on the recovery of wetland areas that were not yet excessively impacted by urbanization.

This process resulted in the resettlement, in the early 2000s, of 160 families living in the wetland area, through working groups promoted by the Sector Committee of the surrounding communities and the city government, with the aim of guaranteeing the rights of these for the most part vulnerable populations. As a result of this working group, a program for the recovery of the La Vaca (North) WDEP was consolidated. In this process, community organizations from the neighboring communities such as Bancos de Semillas and its leader, Dora Villalobos, assumed the leadership of the processes of conservation and restoration of the wetland, implementing methodologies of dialogue and consultation, self-management, and the use of legal resources with the competent entities, such as the filing of the popular action 04-0016 of 2004, to ensure compliance with the recovery program of the La Vaca (North) WDEP.

Since the end of the 2000s, a monitoring committee has been established to follow up on the wetland recovery program and the implementation of its Environmental Management Plan with the participation of citizens, economic actors from the surrounding area, and city government institutions. By 2010, an environmental classroom was built and, since 2015, environmental and community monitoring processes and participatory ecological restoration processes have been implemented more frequently.

Achievements, effects and impacts

The main achievement has been the recovery of a large part of the functions of the WDEP La Vaca (North), through actions such as the hydrogeomorphological reformation of the water body and the ecological restoration by planting trees, shrubs and grasses. This initiative has been considered as a reference of citizen participation together with the work of the District institutions.

The implementation of a natural biofilter developed from the planting of reeds (Schoenoplectus californicus) is highlighted, as well as the process of correcting erroneous connections, the control of spills, the planting of approximately 1,816 trees and native bushes, and the planting of a total of 1,816 trees and bushes. 816 native trees and bushes such as the Peach (Abatia parviflora), Chilco (Baccharis latifolia), Tomatillo (Solanum ovalifolium), Lupine (Lupinus mutabilis), Alder (Alnus acuminata), Wax Laurel (Morella pubescens), Sangregado (Croton funckianus), Pino romerón (Retrophyllum rospigliosii), Cedar (Cedrela montana), and Walnut (Juglans neotropica), among others, and tall trees such as Willow (Salix humboldtiana) (Figure 2). These actions have significantly improved the water quality of the wetland and have promoted the recovery of aquatic and terrestrial flora, along with its associated fauna. During 2020, 200 individuals of native plant species were planted, under the direction of the District Secretariat of the Environment as environmental authority, with the support of allied entities and citizen participation.

The ecological restoration and participatory restoration processes have allowed the recovery of the wetland soils and a diversity of native flora species.

Likewise, progress was made in the acquisition of the land located in the wetland's Environmental Management and Preservation Zone (ZMPA), the resettlement of communities located on the wetland was completed, and the removal of garbage and fill material from the water mirror was carried out.

The appropriation and participation of the neighboring communities and inhabitants has been one of the greatest achievements for the conservation and recovery of this ecosystem. This participation has transformed this initiative into a reference of participation and articulation of the communities and public institutions for the recovery of a wetland ecosystem and for the environmental education of the city.

Figure 2. Location of native trees and shrubs planted in the WDEP La Vaca (North). Source: SDA, 2021.

What made the success of this experience possible

Undoubtedly, citizen participation has been fundamental in generating proposals and actions for the conservation and restoration of the wetland. This has allowed cooperation and learning between the community and the institutions.

Social and institutional learning over the decades has seen models and processes of environmental governance for the conservation of the city's wetlands mature. The growing environmental awareness of district institutions and citizens in general is highlighted.

The inter-institutional cooperation, in this case between the current District Secretary of the Environment (formerly the Administrative Department of the Environment), the Bogotá Water and Sewage Company E.S.P. (EAAB E.S.P.) and the local authorities, is a model of joint work in favor of the wetland.

Lessons learned

The development of a regulatory model that adapts to the needs and socioeconomic context of the wetland. This ranges from the Capital District's public policy on wetlands, its action plan and its prioritization, to the implementation of Environmental Management Plans that must be updated periodically.

The creation of an administration or governance model for the city's wetlands that prioritizes the needs of each ecosystem with a strong commitment to citizen participation.

The importance of establishing the regime of permitted and prohibited uses within the defined wetland areas.

Environmental education and social management as strategies for citizen awareness and sensitization.

Sustainability Perspectives

A solid and appropriate regulatory framework for institutions and citizens, including the Ramsar Convention, national legislation, and the construction of the Capital District's public policy on wetlands, the Land Management Plan and the Environmental Management Plans for each of the city's wetlands.

Generational relay, to the extent that all age groups receive environmental education according to the socioeconomic context for the protection and recovery of their environmental heritage.

Community Research and Innovation Center as an epicenter to recognize the ecosystem through research.

Empowerment of the community to assume the care and management of the ecosystem.

Credits: Dora Villalobos Burgos.

Photographs: La vaca wetland.

ECUADOR

6. Restoration of the Chakana wetland (Ecuador)

Chakana Reserve (Antisanilla farm)

- Stakeholders Involved

  Universidad San Francisco de Quito
  Fundación de Conservación Jocotoco

- Authors/ Institution

  Esteban Suárez / Segundo Chimbolema / Antonio Páez / Adela Espinosa / Marcelo "Pancho" Cuichán / Fernando Males

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Description of the Experience

The Chakana wetland is a peatland of approximately 21.3 ha (0°26'46.25 "S; 78°18'25.36 "W) located in the province of Pichincha, on the grounds of the former Antisanilla hacienda. This peat bog is located at 3770 m on a wide plateau that borders the eastern flank of the Boliche or Muertepungo lava flow. Its longest axis descends in a southeasterly direction from 3798 to 3744 m elevation and with an average slope of 7.4%.

Credits: USFQ.

Photograph: Chakana Reserve, Jocotoco Foundation.

Being part of the extensive páramos that rise towards the Antisana volcano, the Antisanilla property has experienced a long history of use. In 1802, Alexander von Humboldt visited here, and in 1881, British explorer and mountaineer Edward Whymper toured this area and, in fact, spent a night in the old ranch house that to this day stands between the Muertepungo lava flow and the Chakana wetland. In his account of the first ascent of Antisana, Whymper describes a huge caravan of chagras (cowboys) who rode up on their horses to herd the countless herds of cattle that grazed on the volcano's extensive slopes.

For centuries, and until very recently, these páramos have been constantly used for cattle and sheep ranching, with the consequent fires that often accompany livestock practices in the humid páramos of Colombia and Ecuador. And, although we do not have more detailed information, we know that until 2014 the Antisanilla area was an active grazing site for a herd that fluctuated between 600 and 1400 head of cattle. As part of the management of this area, at a date that has been impossible to determine, the former owners of the Antisanilla ranch opened at least five longitudinal canals and two oblique canals in the peatland, forming a 3.16 km long ditch system. Additionally, a 0.76 km ditch was opened (Canal H, Figure 2) that cut through the headwaters of the peatland, diverting a large amount of water that should have entered the wetland. The cutting of these canals, coupled with constant grazing by the ranch's cattle, turned the peatland into a large pasture dominated by exotic grazing-resistant species such as Anthoxanthum odoratum, Cotula australis, and Poa annua.

In 2014, the Antisanilla property was purchased by the Jocotoco Conservation Foundation, resulting in the implementation of several strategies to reduce cattle pressure and restore native ecosystems. In addition to the reduction of the cattle herd and its exclusion from the peatland area, 20 additional canals were cut in 2016, parallel to the wetland slope lines and with a total length of 4.86 km (Figure 2). These canals were opened with the intention of facilitating habitat for waterfowl, but had the inadvertent consequence of accelerating the drainage of the peatland, increasing the urgency of implementing a restoration process of the wetland's hydrology and vegetation.

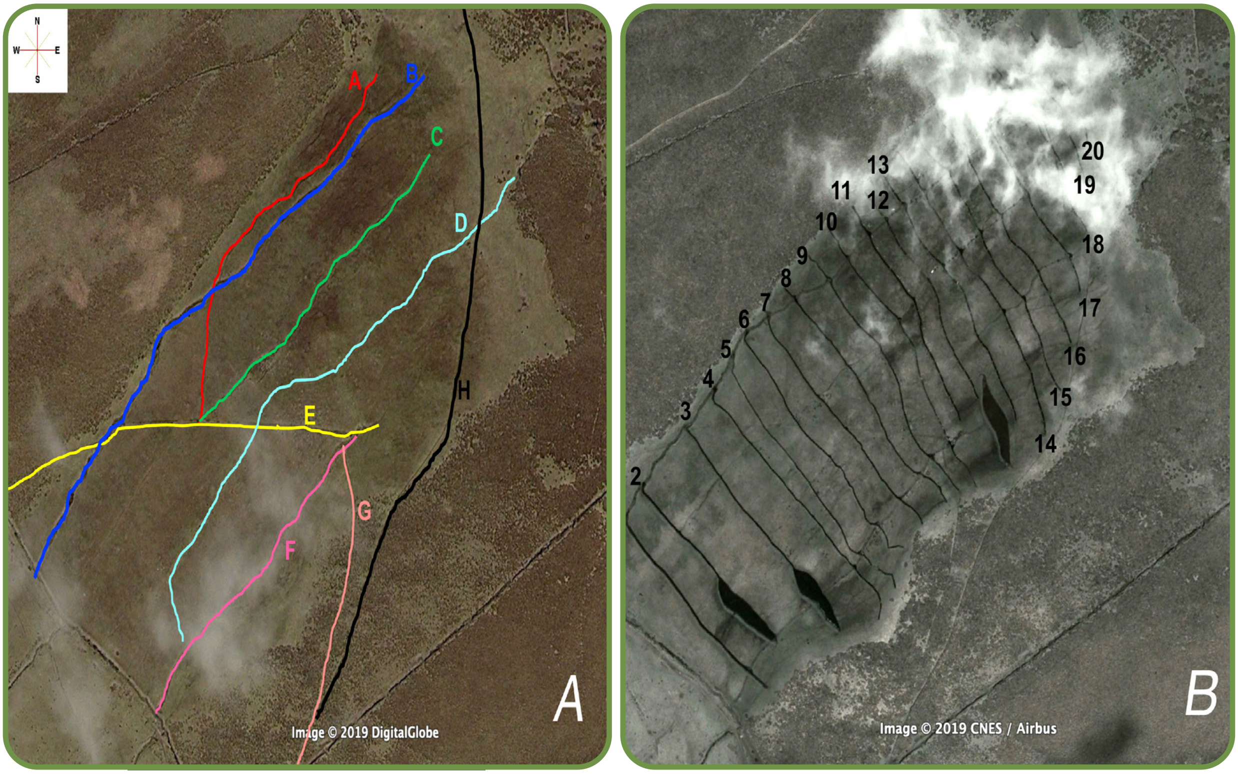

Figure 2. Canals in the Chakana Reserve

Process of Restoration

Starting in November 2017, planning for the restoration of the Chakana peatland was begun, based on a collaboration agreement between the Universidad San Francisco de Quito and the Jocotoco Foundation, and with the technical support of scientists from Michigan Technological University and the U.S. Forest Service. In preparation for the restoration, in February 2017 we installed a system of six water table wells that were to be monitored every two weeks by an environmental manager from the Foundation.

The water table baseline was supplemented with two vegetation monitoring systems. For the first system, we stratified a total of 30 90 x 90 cm quadrats, trying to cover all vegetation types observed in the peatland. Within each quadrat we used a system of 81 intersection points every 10 cm to estimate cover and species composition. For the second system, we used the same 90 x 90 quadrat to monitor vegetation dynamics in the cross-canals. For this system, we established three quadrats randomly located in each of four canals (canals 18, 16, 9 and 6).

The canal neutralization process was carried out in two phases. In the first phase (November-December 2017) we blocked the canals in the uppermost part of the peatland (canals 11 to 20; Figure 2), and initiated work in longitudinal canals A, B, C, D, and H. By initiating restoration in the upper zone, we sought to progressively reduce the energy and volume of water flowing through the transverse canals. In the second phase (January-February 2018) we blocked canals 1 to 10, and completed work on the longitudinal canals. For the transverse canals, we used hay bales to build about 350 blockages, while for the longitudinal canals we used 50 barriers built with rustic wood planks. In some canals that were particularly wide and deep, we used wooden barriers combined with hay bales installed on the lower (downstream) side of the barrier to help stabilize it and allow for vegetation colonization.

Preliminary results and evaluation of the restoration:

In the case of Chakana, the results of the restoration process can be analyzed at three levels: colonization of longitudinal canals, colonization of transverse canals and changes in the vegetation matrix.

Longitudinal canals: In the Chakana wetland, the longitudinal canals coincide with the wettest areas of the peatland, that is, the lowest areas through which water tends to circulate. Because of their higher humidity, these areas had small patches of Juncus sp. (cattail) limited to the edges of the canals before restoration. After the construction of the barriers, the wetlands expanded along the canals and promoted a rapid extension of the cattail patches (Figure 3).

Figure 3. Patches of cattail that colonized areas of the canals.

Transverse canals: The transverse canals represented a particular problem at this site. On the one hand, the canals were numerous and extensive, with average widths of 1.5 m and depths varying between 25 and 40 cm. On the other hand, being interconnected through the longitudinal canals, the canals in the lower part of the peatland moved much larger quantities of water than those in the upper part. Given these circumstances, these canals were blocked with hay barriers and their restoration is developing from a process of secondary succession triggered by the immobilization of water in the canals.

By limiting water movement, the channels went from behaving as a lotic system to a lentic state with almost stagnant water. This stagnation resulted in the formation of thick layers of algae, which appeared within 3 months of canal blockage. In some cases, these algae layers covered almost the entire water mirror of the canals. At the same time, unable to flow through the canals, the water began to percolate or slowly overflow, resulting in rapid saturation of the soil in the spaces between the canals.

Approximately 3 months after the neutralization of the canals, the algae began to die and their biomass, upon decomposition, began to serve as substrate for a gradual colonization, first by aquatic plants and then by typical wetland plants such as Caltha sagitatta and Rannunculus flagelliformis. Finally, approximately 18 months after the beginning of the restoration, the channels began to be colonized by Eleocharis dombeyana which, in some sections, has already completely closed the water mirror of the shallower channels in the upper part of the wetland. This successional process can be seen in the example in Figure 4, which shows the change in channel cover in two permanent quadrants. In these examples, vegetation cover increased from 10% to about 80% in 3 years, through a dynamic process of i) disappearance of algae, ii) increase and subsequent decline of aquatic plant cover, and iii) eventual dominance of Eleocharis dombeyana.

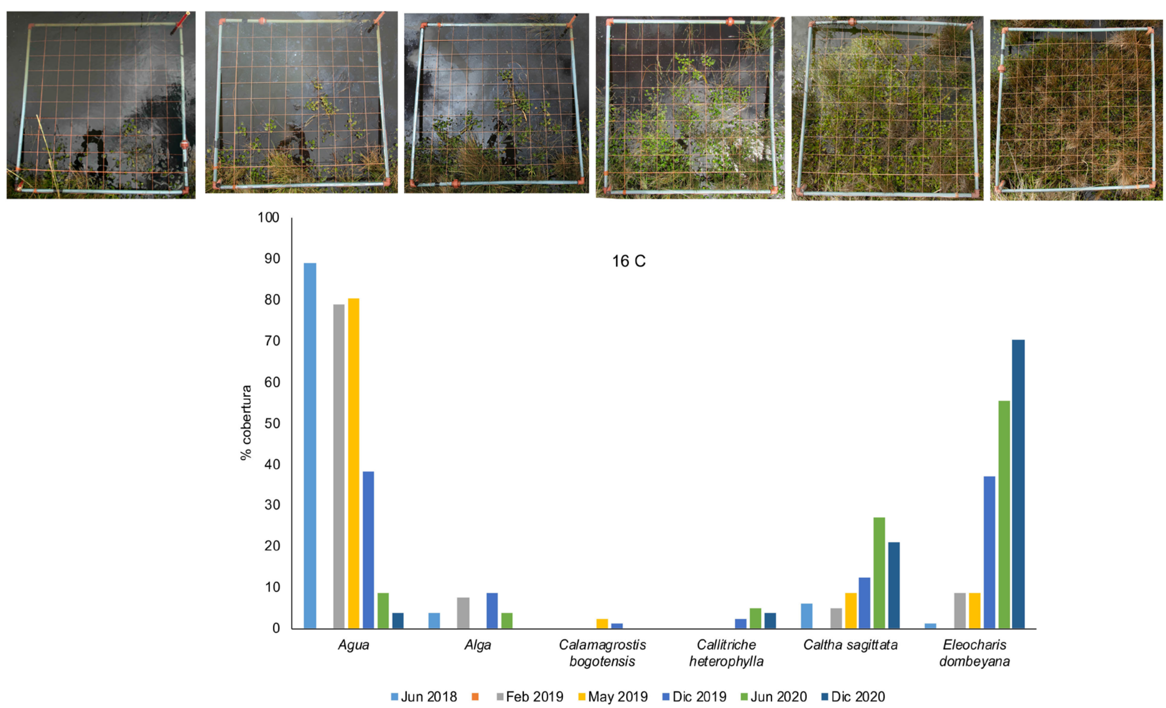

Figure 4. Change in canal coverage after implementation of the restoration during the period 2018 - 2020..

This succession process was not homogeneous between canals. In deeper canals, the process has been much slower and, in some cases, almost imperceptible. In these locations, passive canal restoration may not be sufficient and additional effort may be required to reduce the depth of the canals and/or provide an initial.

As for changes in the general vegetation matrix of the wetland, we do not yet have a definitive analysis of the data, but our observations suggest that an integral change is taking place with a decrease in exotic species and an increase in species typical of high Andean peatlands such as Plantago rigida cushions, cattails, and several species of Cyperaceae.

Achievements, effects and impacts

So far, this restoration initiative has had verifiable results in two areas. On the one hand, monitoring results show changes in vegetation cover that are consistent with a recovery of the peatland's functionality. The canals, for example, have lost their water mirror and are being colonized by vegetation typical of páramo wetlands. Likewise, the longitudinal canals are becoming less evident and are filling up with cattails and other species that reduce water movement, stabilize the canals, and provide habitat for other plant and animal species typical of peatlands. On the other hand, this process has allowed the development and adaptation of páramo peatland restoration techniques that will serve as a basis for guiding and promoting other similar projects.

From this perspective, and once the changes in the vegetation are evident, the next steps of this project are aimed at quantifying the possible effects of the restoration on the dynamics of the carbon stored in the peatland. This includes, mainly, quantification of the productivity and above and belowground biomass of the vegetation, and an assessment of the spatial and temporal patterns of greenhouse gas emissions.

What made the success of this experience possible

The main strengths for the success of this initiative have been trust and a strong commitment to collaboration among the institutions involved. On the academic side, Universidad San Francisco de Quito provided the design, technical management, and monitoring of the entire initiative. On the conservation organization side, Jocotoco provided free access to the area, funds for restoration, and support and accompaniment in all phases of the project. From this perspective, the development of the initiative has been a collaborative process with clear and shared goals that have ensured the smooth functioning of the project.

Lessons Learned

At the technical level, this initiative demonstrated that, if pressures are effectively removed, the recovery of the peatland vegetation can proceed with relative speed. In this sense, the almost complete removal of grazing on the peatland has been key to facilitating its recovery.

The drainage blocking techniques used in this initiative are effective, easy to implement, and relatively inexpensive. In particular, the use of hay bales to block channels proved to be efficient not only in limiting water movement, but also in helping to restore relief and fill deeper channels. Additionally, the placement of vegetation mats on top of the levees accelerates their stabilization and allows them to be lost over time, contributing to a “more natural” look to the restored channels.

Our vegetation monitoring system before, during and after restoration has been effective in documenting the vegetation recovery process and is fundamental to enable management and evaluation of the initiative. In contrast, our water table monitoring system had implementation problems that prevented us from establishing a solid baseline prior to restoration. From this perspective, so far our data do not allow us to establish whether the water table in the wetland has responded to the restoration measures, although these changes seem evident in the response of the vegetation.

The evaluation of a restoration process requires as complete a baseline of information as possible to be generated prior to the restoration process. Without such a baseline, monitoring and adaptive management of the initiative are difficult and have high levels of uncertainty. In this context, the development of sensitive but easy to implement indicators is recommended to assess the trajectory and progress of restoration processes.

Sustainability Perspectives

In the particular case of the Chakana peatland, the sustainability of the restoration initiative is guaranteed by the land tenure conditions and the objectives of the Jocotoco Foundation. The fact that the peatland belongs to a non-profit conservation foundation ensures that the land use will not change in the near future. As for the funds for the restoration, it is estimated that the initial investment was the largest because it required the neutralization of the canals. But once that initial phase has been overcome, the passive restoration of the peatland should not require a high level of funding.

7. Restauración del humedal Pugllohuma

Pugllohuma

- Stakeholders Involved

  FONAG/ Quito Water Company EPMAPS/ TNC/
  Universidad San Francisco de Quito

- Author/ Institution

  Paola Fuentes/ Luna Delerue/ Bert de Bievre
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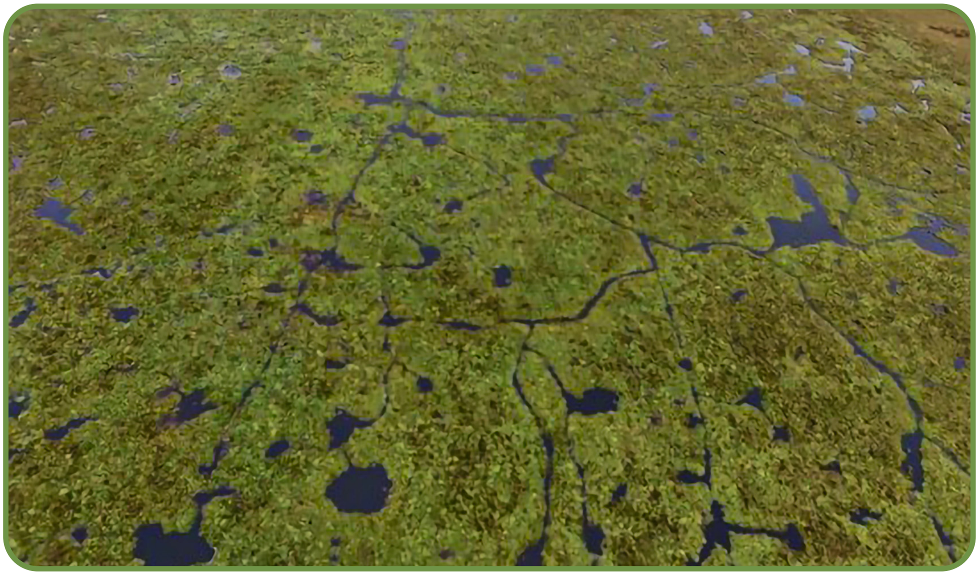
Description of the experience

The Pugllohuma wetland is about 14 hectares in size and is located in the Antisana Water Conservation Area, which is managed by FONAG and borders the Antisana Ecological Reserve. It is a contributor to the Antisana River, whose flow is captured by the Empresa de Agua Potable de Quito for the La Mica South Quito system. The wetland is located at 4115 m.a.s.l.; its average annual rainfall is 800 mm and its average temperature is 6.5 °C. It has a slope of 6.65°, which corresponds to an almost flat terrain, where runoff tends to be low.

Until 2010 and for more than 100 years, this wetland was part of the extensive Antisana hacienda. In 2011, the Empresa Pública Metropolitana de Agua Potable y Saneamiento de Quito (EPMAPS) purchased the area in order to protect the micro-watersheds that supply water to the city. Anthropogenic actions in Pugllohuma date back more than a century. During the hacienda regime there were approximately 22,000 animals (cattle, horses and sheep), including 17,000 sheep. The Pugllohuma wetland was one of the ecosystems within the hacienda that was used for cattle ranching, for which "sangradera" ditches were built to drain it and thus facilitate the entry of livestock. According to personnel who worked at the site, this action prevented "the sheep from consuming the water and getting sick" (FONAG, 2016). Figure 1 shows about 3680 meters of artificial drains that connect almost 100 pools to a main natural drainage.

Credits: FONAG

Figure 1. Artificial drainages



Credits: FONAG

Figure 1. Artificial drainages

The process of restoration

The Pugllohuma wetland is seasonal. Although it receives subsurface and subterranean runoff flows from its neighboring slopes, its saturation depends largely on precipitation. This condition causes the wetland to have a variable water table and the impact of desiccation to be greater (Figure 2)

Credits: FONAG

Figura 2. Water table variability

The peat profile is not permanently saturated, and the drainage ditches have lowered the water level, which could be reflected in water regulation and the ecosystem's resilience and response to restoration. To mitigate dewatering by drains or artificial ditches and improve the water conditions of the altered peatland, the drains were blocked with wooden dams, a technique that was used because it was easy and inexpensive to implement.

In the first phase, 50 dams were built in the ditches with the highest water flow velocity and the largest size (Figure 3). During the second phase, in May 2018, 100 additional dams were constructed.

Figure 3. (a) Blockage at the outlet of a pool and (b) Blockage in a drainage system.

Monitoring of the restoration

The results of the restoration process can be analyzed in four indicators: water dynamics, soil physicochemical properties and vegetation.

Water Dynamics

The artificial drainage systems (Figure 1) largely control the depth or level of the water mirror. To understand these dynamics, the water table was evaluated before and after restoration. For this purpose, 18 1 m deep wells were installed in which the water table was measured one year before dam installation (baseline) and after restoration.

The wells were distributed in four transects perpendicular to the drainages. In addition, two automatic level sensors were installed that record levels every 5 minutes. With the data from the automatic sensors, the constant of the water table recession time in dry periods following rainfall events was calculated based on the linear reservoir model (Buytaert, et al. 2004). This analysis in dry periods after rainfall events allows the analysis of the behavior of the retention capacity of the wetland, and has the advantage of being independent of the initial water table.

Vegetation

In order to obtain the baseline of the vegetation composition of the wetland, line transects were established in two phases. First phase: in 2016, before the start of the restoration, three 50 m line transects were established distributed in the wetland in three zones: in the upper part affected by the presence of pools; in the middle part, where there is greater saturation and higher density of drainage; and in the lower part, where a change from semi-aquatic to tolerant vegetation and meadow could be observed. The information was recorded using the methodology of intercept points every 50 cm to estimate the cover and species composition. This methodology was repeated in a second sampling in 2019 to check its effectiveness and analyze if there was any change.

Second phase: in order to sample areas where changes can be seen in less time as a consequence of the blockage in the drainage, three 30 m transects were established with five 1m2 quadrats separated every 5 m; that is, a 1m2 quadrat was located in the flooded area of the drainage and the other quadrats away from that area. Additionally, 25 points of intersection, vegetation cover, necromass, water and bare soil were recorded within each quadrat. In both methodologies, the richness, abundance, diversity, dominance and similarity of each of the transects were analyzed.

Achievements, effects and impacts

As a result of blocking the drains, the range between the maximum and minimum water table levels should be expected to decrease. This pattern would reflect better regulation of the wetland, i.e., more constant water tables in the dry season. The water table is affected by drainage; however, the magnitude of the impact measured in wells may vary according to their distance from the dams. Wells located near dams may exhibit a greater response due to the area of flooding caused by blockage than those that are distant. On average, the water table in wells near blocked drains is 8% higher than in wells distant from the blockages; however, it still does not reach the level of wells located in undrained areas whose average water table is 10% higher.

To understand the effect of the dams over time, the period from November 2016 to November 2017 was considered as the pre-blockage baseline and until November 2018 the blockage evaluation. The year evaluated after restoration was much drier (200 mm less). In the pre-blocking year, wells in areas without drains had a water table 11 % higher than wells near drains. After blocking the response was reversed, and wells near drains had a water table 11% higher than wells without drains nearby. This pattern suggests that the dams help support the water table during the dry season.

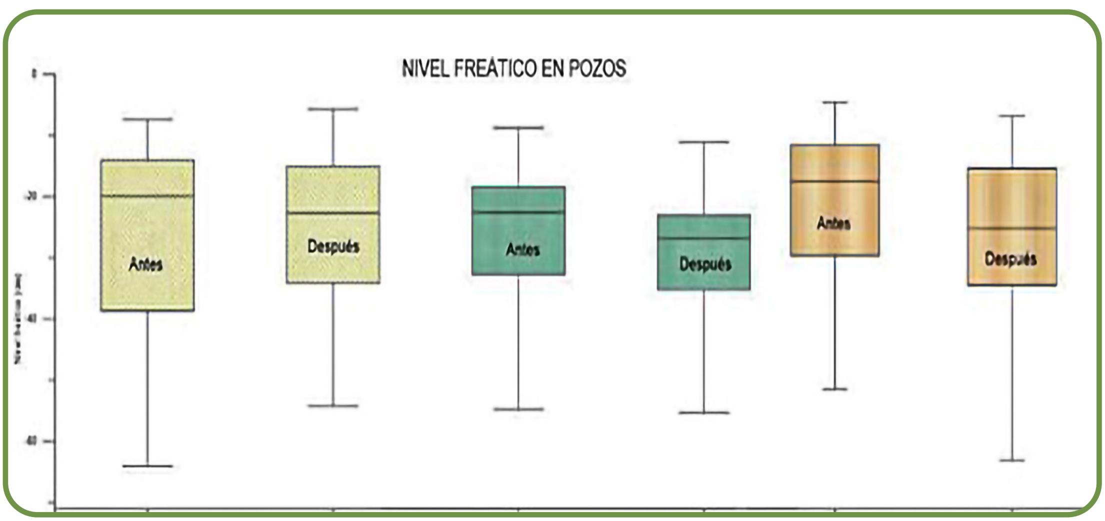


Figure 4. Box plots of manual measurements before and after blockage (A) Near drains (B) Far from drains and (C) No drainage in the area.

In the wells near the artificial drains (Figure 4 A) after blocking, the interquartile range is reduced despite being a drier year. The influence of climate is seen both in the wells “distant to drains” and in the wells without drains (Figure 4 B and C).

The interquartile range of the water table in wells near blocked drains is reduced on average by 4 cm (21%).

Recession time constant

Water height data at the well where an automatic sensor was placed were analyzed in episodes of no rainfall for several days to identify the characteristic time constant of wetland draining. Six were analyzed in the baseline period, and seven in the years following restoration. The results obtained indicate that on average the characteristic recession time increases after blockage, from 17 days ± 12% to 24 days ± 18%, which means that water leaves the wetland more slowly after restoration.

Vegetation

The highest percentage of vegetation cover corresponds to Plantago rigida and the transects were very similar to each other. The areas near the drainages tend to be dominated by species tolerant to high levels of flooding such as Plantago rigida pads, while erect herbaceous and tillering species are less frequent.

The necromass can be confused with species that change their physical appearance during the dry period within drainages, such as some bryophyte species that remain dormant during drought (Hernández and Monasterio 2005). For this reason, a proposal is being developed for a more detailed study on the role of bryophytes after restoration.

What made the success of this experience possible

UA key factor for the success of our experience is that the Antisana Water Conservation Area belongs to the Quito Potable Water Company and is managed in coordination with FONAG, through the participation of a team of park rangers from both institutions in the area. As this is an area whose exclusive use is for conservation and recovery, where research can be carried out to strengthen the understanding of páramo ecosystems, including wetlands.

Another relevant factor was the support of academia. With the support of the Universidad San Francisco de Quito, in June 2017 the dams were installed - on a trial basis - as part of the Peatland Restoration Workshop organized by this institution. Also, the Agua y Páramo Scientific Station promotes research in the area to complement the understanding of peatlands.

FONAG also considers it important to monitor the impact of conservation actions and has a technical team in charge of follow-up, maintenance of the installed sensors, and analysis of the information

Lessons learned

It is necessary to constantly monitor indicators of change that may be relevant to evaluate restoration processes. For example, in addition to flow rate, another relevant indicator in our case is dissolved organic carbon, which was not considered from the beginning in our monitoring.

Field data recording and information processing are key to obtain valid conclusions and maintain data quality. For this reason, FONAG has incorporated virtual platforms for data collection and processing.

It is important to generate indicators that reflect the hypotheses proposed in relation to the restoration and management processes.

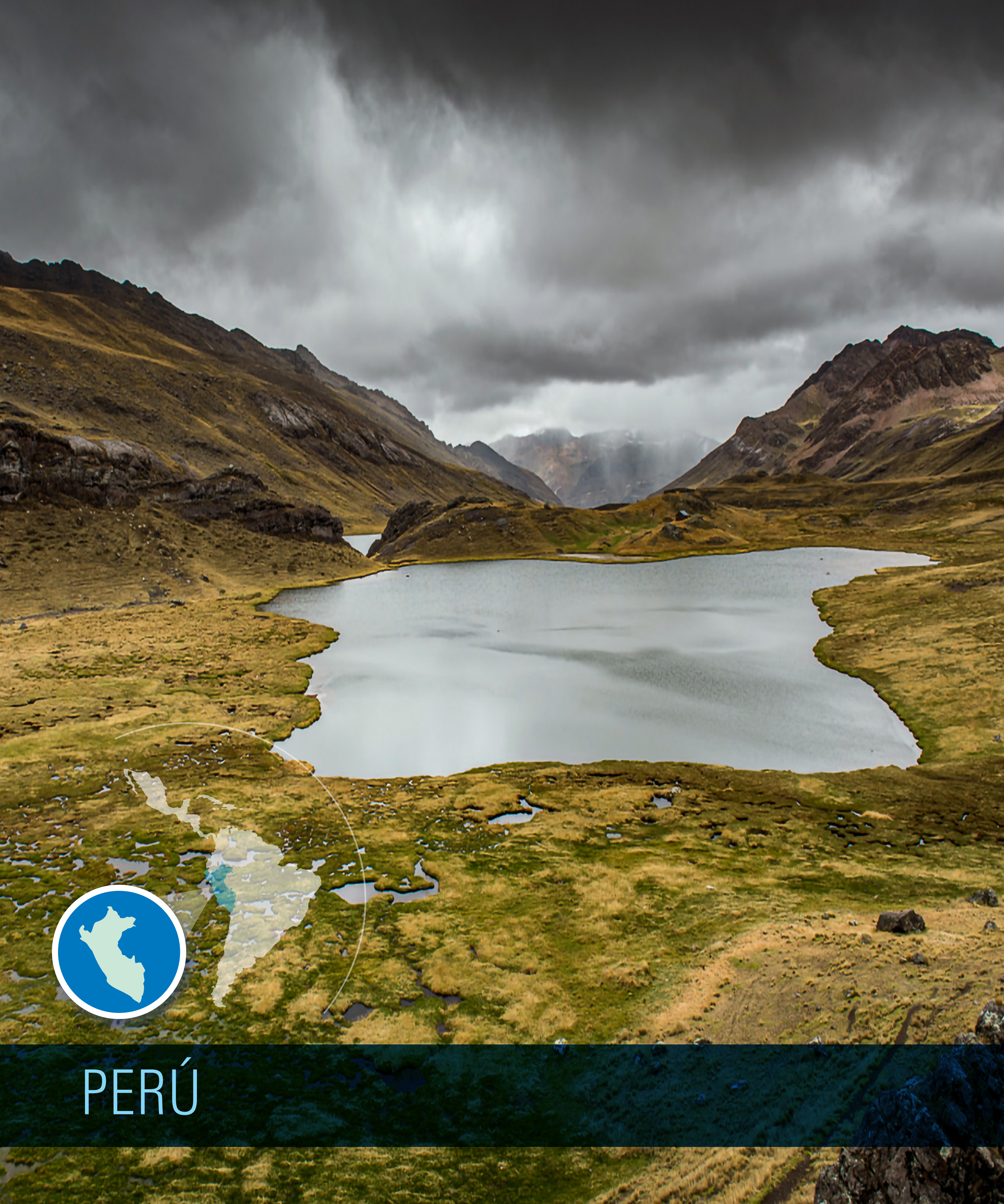
So far we have taken the first step, which is to characterize the vegetation life forms shortly after restoration. The next step will be the functional characterization of the vegetation in order to delve into the different adaptive strategies of the species as the wetland changes from a mainly terrestrial environment to a semi-aquatic environment. With this information it will be possible to answer questions about how succession processes occur in a wetland on the way to its recovery, i.e., how the ecosystem dynamics occur.

Sustainability perspectives

The restoration of the Pugllohuma wetland has a long-term horizon. This is due to the fact that it is located in its own property destined for conservation. Although this is not an easy condition to replicate in other sites or for other institutions, in the case of this research its sustainability is guaranteed.

An important aspect in terms of sustainability for FONAG is capacity building, both for the monitoring team (technicians and professionals) and for the Guardapáramos (páramo park rangers) team. The Guardapáramos, by remaining in the area after a process of training and accompaniment, can play an important role in data collection.

Finally, the involvement of academia through the Water and Páramo Scientific Station allows the establishment of complementary lines of research to comprehensively understand the water source ecosystems. University researchers have seen a good opportunity to undertake medium and long-term research projects in the area.



PERÚ

8. Management and recovery of wetlands to improve water retention in the Punchaucocha sector, Perú

Humedales de Punchaucocha

- Stakeholders Involved

Laraos Rural Community
Ministry of Environment - MERESE FIDA Project
District Municipality of Laraos
National Service of Natural Areas Protected by the State (SERNANP), through the Nor Yauyos Cochas Landscape Reserve.

- Authors/ Institution

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Description of the experience

The Laraos Rural Community is located in the district of Laraos, province of Yauyos, department of Lima. It is located at an altitude of 3,550 m.a.s.l. and its territory is part of the Nor-Yauyos Cochas Landscape Reserve.

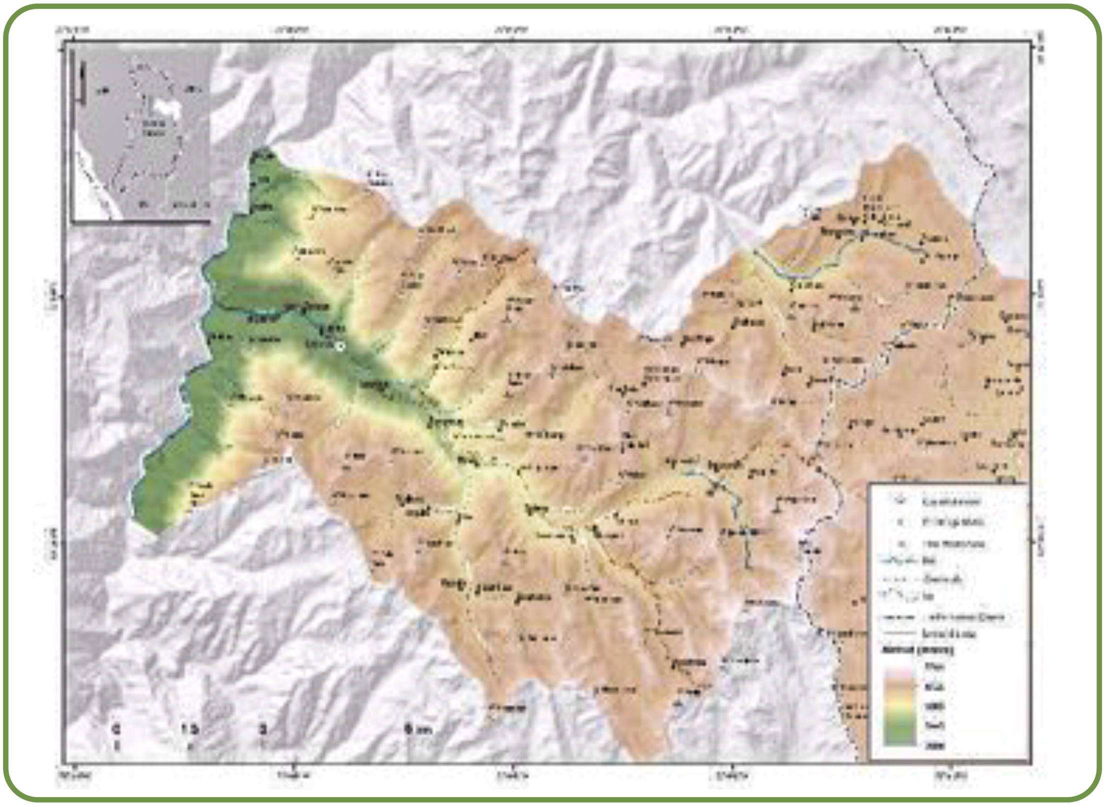

Figure 1. Site Map.

The main economic activity that generates income is camelid livestock, especially alpacas for the sale of fiber and meat. Agriculture is primarily for self-consumption and is characterized by the use of terraces.

However, this economic activity has also caused problems in the Pachaucocha wetlands due to overgrazing by alpacas and cattle. The sheep, cattle and alpacas that are raised in the highlands drink water mainly from the wetlands. The alpacas are the ones that feed the most on the wetlands. This has caused the reduction of vegetative cover, compacted soil and loss of infiltration capacity, reducing the wetlands.

Faced with this problem, the Laraos Campesino Community decided to participate in the First Contest for the presentation of subprojects for the conservation and sustainable use of high Andean ecosystems in the Cañete Basin, organized by the MERESE-FIDA Project, executed by MINAM. In this way, funding was obtained for the implementation of the subproject "Management and recovery of wetlands to improve water retention in the Punchaucocha sector" presented by the Laraos Peasant Community, whose main objective was to recover 85 hectares of degraded wetlands due to excess animal carrying capacity. This initiative was also supported by the Laraos District Municipality.

The subproject "Management and recovery of wetlands to improve water retention in the Punchaucocha sector" had three specific objectives: protect the wetlands with cattle netting, install Gramineae in degraded areas, and build internal canals to increase wetland areas.

Before implementing the field activities to achieve the objectives described in the subproject "Management and recovery of wetlands to improve water retention in the Punchaucocha sector", the community received technical assistance through training to collect cuttings of native grass species, to dig holes in the soil and how to transplant, to lay out the canals at zero slope to allow the soil to be dug and moistened.

Once the community was trained, field activities began, such as the transplanting of grasses and installation of gramineae, the layout and construction of internal water distribution channels, and the installation of perimeter fences for conservation purposes. For the transplanting of grasses and installation of grasses, three species of native grasses for wetlands were used: Calamagrostis ovata (Shura), Festucar F (Dolichophylla) and F. gimnanta (Chojo). Regarding the activity of layout and construction of internal water distribution canals, communal work was carried out to lay out zero-slope canals that allow the soil to be dug and moistened to provide moisture for the plants, and the layout will allow water from the springs or streams to be transported or conducted to the dry areas. Finally, galvanized tubes and 9-wire cattle netting were used to install the fence for conservation purposes.

A key factor for the success of the activities was the commitment of the beneficiary families to carry out the subproject's actions. The families organized themselves to carry out the field work by means of workdays, after reaching a consensus with the Community Assembly where the cost per hour of work was determined. It should be noted that most of this work was valued as a counterpart of the community to the subproject, that is, they were not paid directly by the Project.

The achievement of these actions has contributed to the recovery of 85 hectares of wetlands, 8 hectares of reseeding of Gramineae with native grass species, and the construction of 16 hectares of internal distribution channels. This has made it possible to improve and recover the vegetation cover, and to count on the presence of birds in the lagoon.

Credits: Michell León.

Photographs: MERESE-FIDA.

With the actions carried out, an exchange of experiences was carried out to show the achievement of the actions to the stakeholders (EMAPA Cañete, Board of Users, NGOs, among others) and decision makers of the lower part of the basin in order to promote and implement the Mechanism of Remuneration for Ecosystem Services.

Credits: Michell León.

Photographs: MERESE-FIDA Proyect (MINAM).

Achievements, effects and impacts

The implementation of this experience led to the following achievements:

- Recovery of 85 hectares of degraded wetlands of the Punchaucocha lagoon, tributary to the Huanpuna river.
- Adequate water distribution to potential wetland areas and improvement of installed gramineae due to the construction of 16 ha of internal canals.
- Increase or improvement in vegetation cover through the replanting of native species of gramineae planted throughout 8 hectares.
- Change in the behavior of leaders and community members regarding the importance of conserving ecosystems.
- Training of community members in topics related to the implementation of the subproject actions, which will allow them to replicate it in their other activities.
- Training for community members to optimize the development of productive activities, such as sustainable agriculture and aquaculture.

What made the success of the experience possible?

- The factors that contributed to the success of the experience are as follows:
- The commitment of community members to carry out actions in the field.
- Counseling and permanent support in the execution of the subproject activities.

- Ongoing training in the management of economic resources to ensure that resources are invested in accordance with the subproject.
- The support of local institutions, such as the District Municipality of Laraos and the Nor-Yauyos Cochas Landscape Reserve.

Lessons learned

- Planning the activities considering the seasons. This made it possible to take better advantage of rainy seasons for the development of natural grass seedlings and also to avoid delays in the execution of other activities.
- Consider expenses for the hiring of technical and administrative personnel in the budget, to facilitate the preparation of reports or administrative procedures required by the subproject.
- With the coordinated work between local stakeholders, subprojects can be developed that benefit the high Andean ecosystems for the use of the communities in the upper part of the basins, as well as in the lower part of the basins.

Sustainability Perspectives

In order to make the actions carried out with the subproject sustainable, the local community committed to the intangibility of the intervention area for a period of 5 years. This has allowed the community to recognize the effort and resources invested, and they have seen an opportunity to promote landscape tourism.

On the other hand, it is seen as an opportunity for funding by the conservation organizations in the area, through MERESE.

The actions carried out with the subproject are located within the buffer area of the Nor-Yauyos Cochas Landscape Reserve, which with its technical assistance will make possible the sustainability of the conservation of these ecosystems.

Credits: Michell León.

Photographs: MERESE-FIDA Proyect (MINAM).

PLURINATIONAL STATE OF BOLIVIA

9. Creation of the National Strategy for the Integrated Management of Wetlands in Bolivia

Ramsar sites: Baths of the Izozog and the Parapetí, Tajzara basin, Bolivian Pantanal, Lakes Poopó and Uru Uru, Lake Titicaca, Concepción Lagoon, Los Lípez, Palmar de las Islas and Salinas de San José, Río Blanco, Río Matos y Río Yata.

- Stakeholders Involved

Bolivian Ministry of Environment and Water, Management and Conservation Unit of the Macroecoregions of the Amazon, Llanos, Yungas, Chiquitania and Pantanal.

Description of the experience

The Plurinational State of Bolivia has the largest extension of wetlands recognized as Ramsar sites, with a total protected area of 14,842,405 hectares (Figure 1). Despite this, there have been multiple human interventions that have endangered these wetlands. Activities such as mining, cattle ranching, and climate change have led to some of them to drying completely, as in the case of Lake Poopó. This has led to significant negative impacts on the biodiversity and hydrological cycle of the sites. This is why, for the conservation and wise use of wetlands, a National Strategy for the Integrated Management of Wetlands and Ramsar sites in Bolivia was created. Through this strategy, Bolivia seeks to join efforts and unify medium- and long-term policies that allow the conservation and sustainable use of wetlands. The creation of the National Strategy contributes to the objectives of the Ramsar Strategic Plan and the Regional Strategy for the conservation and sustainable use of high Andean wetlands.

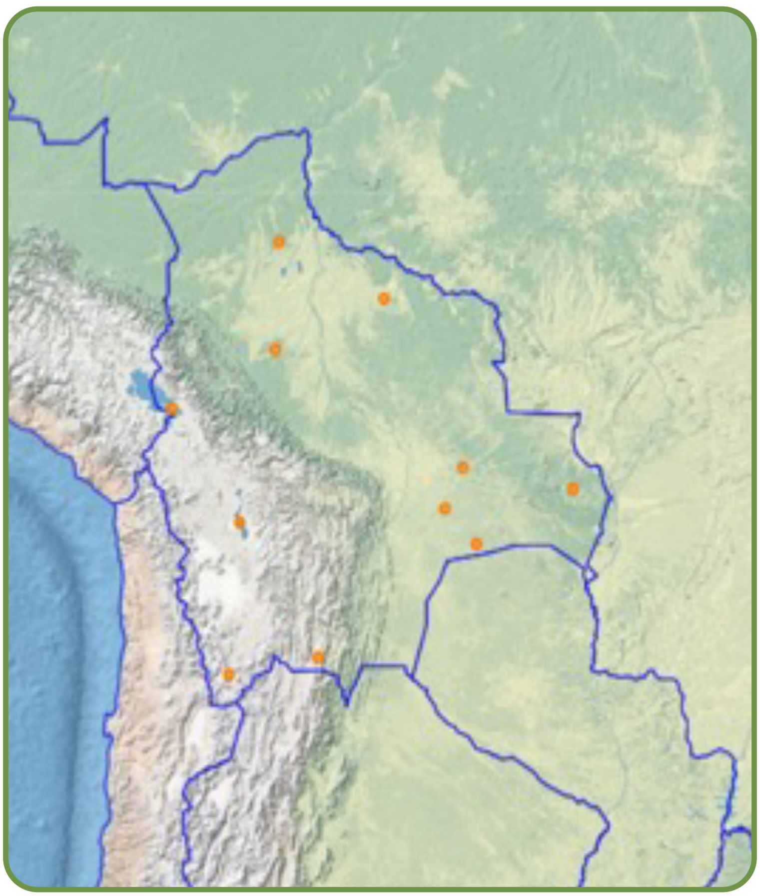

Figure 1. Ramsar Sites in Bolivia. source: ramsar.org.

Achievements, effects and impacts

Through the creation of the National Strategy for the Integrated Management of Wetlands in Bolivia, the following was achieved:

- Creation of a legal and institutional framework.
- Creation of a geodatabase that compiles information on wetlands from various institutions in the country: location, characteristics, spatial and narrative information, socioeconomic data of the population, housing, agricultural data, etc.
- Determination of the current status of wetlands through a detailed analysis of anthropogenic and natural characteristics and pressures in each basin.
- Analysis of the main challenges and obstacles to the conservation and sustainable use of wetlands.
- Establishment of strategic principles and guidelines for the conservation and sustainable use of wetlands.
- Identification of urgent priority activities to carry out specific actions that further the implementation of the National Strategy.

What made the success of this experience possible

The preparation of the National Strategy has an integrated vision that includes an analytical diagnosis considered by basins: endorheic basin, Amazon basin and La Plata basin. This integrated management considers some factors, such as the characterization of wetlands, stressors as well as socioeconomic and environmental implications. Based on this, strategic principles and guidelines as well as operational aspects were considered for the implementation of the strategy with priorities for action. This vision of the National Strategy facilitates its implementation and success.

Lessons Learned

The National Strategy made it possible to consider the structural articulation of environmental, ecological and social functions with the economy. Wetland management is considered in an integrated way through the declaration of protected areas to wide extensions that cover important wetland sites with a vision of a sustainable and balanced development.

Sustainability perspectives

The unification of several local action and management plans into a single National Strategy that considers medium- and long-term priority action plans facilitates the implementation of strategies that lead to the conservation and sustainable use of wetlands.

CHILE

10. Monitoring of wetlands in the Maricunga Salt Flat, Chile

Complejo Lacustre Laguna del Negro Francisco-Laguna Santa Rosa

- Stakeholders Involved

  MMA, CONAF, Center for Applied Ecology, DGA, SAG, Directorate of Planning and Development Regional Government of Atacama.

- Authors/ Institution

  MMA, CONAF, Center for Applied Ecology

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Description of the experience

Due to the threats to the high Andean wetlands present in the Maricunga Salt Flat basin, in the Atacama Region, which have caused environmental damage, with certain wetlands drying up, a project was proposed that would make use of all the environmental information available in the sector, from public services as well as private companies, in order to develop a web based platform that stores this information and in which trends of the stored data can also be visualized. This is in order to be able to foresee when any of the wetlands present in the Maricunga Salt Flat basin are deteriorating, by monitoring forcing variables, such as water level or water mirror area, among other parameters.

Figure 1: Atacama Region (III Region) of Chile.

Figure 2: Ramsar Site Complejo Lacustre Laguna del Negro Francisco-Laguna Santa Rosa (yellow border area) and Nevado de Tres Cruces National Park (green polygons).

Figure 3: Desiccation of a wetland in the Maricunga Salt Flat basin, due to water extraction for productive use.

This project was presented with the support of the intersectoral management committee of the Ramsar site, which is composed of public services with competence in the area in question, such as the Ministry of Environment, National Forestry Corporation, General Directorate of Water, Agricultural and Livestock Service, University of Atacama and Directorate of Planning and Development Regional Government of Atacama. Institutional support for the project was presented through this committee, and the members of the committee participated in the various meetings, workshops, and training sessions that have been held in order to inform or make relevant decisions.

Through the project, equipment was purchased to enable adequate monitoring of the wetland forcing variables that are being tracked. The information monitored by them will be used as input to update the information stored in the web platform and to be able to carry out better environmental monitoring.

Credits: Natalia Penroz.

Photograph: Removal of sensors installed in Laguna Santa Rosa, for data extraction.

Photograph: Lagoon monitoring with multiparameter probe.

The project applied to the Public Goods call of the Production Development Corporation (CORFO), since it focused on the development and sustainability of new productive activities to be developed in the area, mainly associated with the mining sector and special interest tourism, with these two areas being the direct beneficiaries of the project's execution.

It is expected that the web platform will function as an early warning system to support decision making, in order to provide sustainability to productive activities and thus not generate environmental damage in the high Andean wetlands.

Achievements, effects and impacts

It was possible to develop a tool that will store and synthesize all the environmental information generated by various sectors on the monitoring of the wetlands of the Maricunga Salt Flat. This platform allows all those interested in developing any productive activity in the sector to evaluate their environmental conditions and make decisions conducive to making their activity compatible with the protection and conservation of these fragile high Andean ecosystems.

This platform is publicly accessible and can be used to evaluate and define trends in the parameters defined as forcing variables of the high Andean wetlands of the Salar de Maricunga.

In addition, the platform will be updated every six months with new information obtained from the installed sensors, public and private monitoring, which will allow the correct follow-up of the state of the wetlands.

What made the success of this experience possible

Intersectoral work was fundamental to be able to postulate this project and carry it out, which is the result of the work of the Ramsar site's intersectoral management committee.

Regarding the implementation of the project, it was important to have a large public and private database, which served as input for the web platform.

Also important was the support and willingness of the authorities of the participating services and, of course, the financial support of the Chilean Production Development Corporation (Corporación de Fomento de la Producción de Chile).

Lessons learned

The need to have alternatives to carry out the objectives of the project, since due to the sanitary situation caused by Covid-19 many activities had to be modified or be put on hold, so it was necessary to generate other instances to comply with the proposed objectives.

Sustainability Perspectives

Within the call for funding, it was essential to define the sustainability of the public good, with which, the service mandating the project, together with its co-executor, made a commitment to maintain the web platform and update it, in order to keep it useful over time.

Credits: Natalia Penroz.

Photograph: Flamingos in Laguna Santa Rosa-

ARGENTINA

11. Sustainable pastoral management around Laguna de los Pozuelos (Argentina)

Laguna de los Pozuelos Ramsar Site (22º 20' S - 66º 00' W), Jujuy Province

- Stakeholders Involved

Inhabitants of the Pozuelos Basin, National Institute of Agricultural Technology, Undersecretary of Family Agriculture and Territorial Development - Jujuy Coordination, National Parks Administration, Ministry of Environment of the Province of Jujuy, Corporation for the Development of the Pozuelos Basin, National Ministry of Environment and Sustainable Development.

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Description of the experience

Laguna de los Pozuelos is a high Andean wetland located at an elevation of 3,700 meters above sea level, belonging to an endorheic basin of 380,000 ha, in the far north of the province of Jujuy, Argentina.

Due to its biodiversity and great importance to the communities that depend on it for their livelihoods, Laguna de los Pozuelos has been designated a Ramsar Site (1992), a Biosphere Reserve of the MaB-UNESCO Program (1990), a Natural Monument of the National Parks Administration (1981), and, more recently, a Site of International Importance of the Hemispheric Shorebird Reserve Network (2014).

The main threats to this wetland are climate change and overgrazing/trampling by domestic livestock, which are also a factor in the deterioration and loss of wetland areas and their productivity. This has impacts on biodiversity, livelihoods, and the cultural heritage of the communities.

In this context, Fundación Humedales / Wetlands International has worked in this site both at the watershed scale, as well as at the farm level, from April 2017 until the end of 2020 as part of the "Conserving High Andean Wetlands for People and Nature (2017-2024)" Program. On a larger scale, it has facilitated the implementation of the Laguna de los Pozuelos Biosphere Reserve Management Plan in conjunction with local communities and authorities and, simultaneously, on a smaller scale, it has carried out demonstrative pilots of best management practices in its Core zone to have concrete and replicable experiences, in order to address the threats affecting this high Andean wetland.

As part of these exercises, we have contributed to the sustainable management of livestock grazing around Laguna de los Pozuelos, implementing actions for the management and restoration of degraded meadows. In addition, and as a strategy for adapting to climate change, efforts have been made to improve the use of scarce water resources in cattle watering troughs by replacing water troughs fed by the water table with solar pumps.

More specifically, actions linked to the implementation of sustainable livestock grazing practices in the wetlands surrounding the Pozuelos Lagoon included i) the calculation of standing biomass and carrying capacity estimated from livestock exclusion experiments; ii) the development of the livestock grazing management plan agreed with the communities, through participatory and inclusive processes, and with review and technical input from the National Parks Administration (APN), the Undersecretary of Family Agriculture and Territorial Development - Jujuy Coordination (SAF), the National Institute of Agricultural Technology (INTA), and the authorities in charge of the site's administration; and iii) the implementation of this plan, including the management of watering places, resting of grazing areas, adaptation of stocking rates and replacement of sheep with llamas when necessary, among others. The vision of this plan is that all sustainable livestock management carried out in the Laguna de los Pozuelos wetland system will result in improved livestock production in the long term, while contributing to the conservation of the wetlands and the region's biodiversity.

The management and restoration of wetlands was based on the implementation of damsworks of art, in partnership with the communities and local authorities responsible for wetland management, to raise the base level of three watercourses. The purpose of the works was to delay the passage of water, trap sediment to restore the base level degraded by erosion, and recover the clogging of the surrounding wetlands without interrupting the normal flow of water. Raising the base level of the watercourses causes an increase in the level of soil wetting, increasing the productivity of the meadows and wetlands associated with the watercourses. For this purpose, two types of structures were installed: weirs, formed by steps transverse to the water flow at the bottom of the degraded watercourse, built with local material, lined with geotextile membrane fixed to the ground and protected by a cover of surface soil material; and palisades, with steps formed by burlap bags filled with local substrate, aligned, and fixed with wooden stakes. In this way, by improving water storage and retaining rainfall for a longer period of time in these systems, we have sought to contribute to counteracting the wide oscillations between dry and wet periods that intensify the effects of overgrazing.

Figure 1. Location Map

Achievements, effects and impacts

Fundación Humedales / Wetlands International has facilitated the development of the Laguna de los Pozuelos Biosphere Reserve Management Plan (PGRBLP) by working with its local Management Committee. The first draft of this plan was approved by the Argentine MaB Committee, and was submitted for consultation to other institutions. The livestock grazing management plan that has been developed for the site, in consultation with local people and institutions, has been incorporated into the PGRBLP.

To improve local capacity for program implementation, strategic alliances were established with the National Parks Administration (APN), the Undersecretariat of Family Agriculture and Territorial Development - Jujuy Coordination (SAF), and the National Institute of Agricultural Technology (INTA). The program's participatory and inclusive management approach was reflected in the participation of 73 families belonging to nine communities in the program's activities.

In terms of improved grazing practices, work is being carried out with local producers on six rural properties. To date, these guidelines for best practices have been applied in 6,981 ha, jointly with INTA and SAF.

To promote more efficient water use, four solar pumps with water troughs have been installed to replace water sources fed by the water table. In exchange for these improvements, the ranch owners have committed to implement the grazing management plan developed for the site, as well as the reconversion of the drinking trough system.

With respect to wetland restoration, a wetland management and restoration plan was developed that provides management guidelines and identifies potential areas for the implementation of restoration actions. To date, five wetlands have been managed under restoration actions in the protected area (one in Costa Lagunilla, three in Río Chico, and one in Río Cincel), covering a total of 56.6 ha under management.

In terms of communication, the technical publication "Conservation and management of high Andean wetlands in Argentina and Peru" (https://lac.wetlands.org/download/6648/) has been published, which allows the program's approach to be shared with other NGOs, research institutes, enforcement authorities, and the general public.

What made the success of this experience possible

The success of the program is based on addressing the needs related to the local problems detected at the baseline.

Working in consensus with the communities, through a participatory and inclusive approach, was fundamental to carry out the actions in Laguna de los Pozuelos.

It was also essential to have strategic alliances with local actors with extensive experience and work history, such as those accredited by the local partners: APN, SAF, and INTA.

Likewise, it is essential to coordinate at different management scales, both at the national and provincial levels. In this sense, Fundación Humedales / Wetlands International has agreements with the National Ministry of Environment and Sustainable Development (MAyDS) and with the Biodiversity Secretariat of the Ministry of Environment of the Province of Jujuy (Secr. Biodiv. Jujuy).

For the development of the program it was essential to have qualified experts with experience to implement their approaches in the territory, and the sensitivity to work together with the communities.

DOB Ecology's medium-term funding, from 2017 to 2024, facilitated the planning and implementation of the Program, which allows for adjustments and appropriation of the proposals by the communities and institutions in the long term.

Lessons learned

For the restoration of wetlands, it was of utmost importance to rescue ancestral practices from the local communities.

On the other hand, it became evident that, in order to modify management practices that are culturally rooted, and to verify changes in the territory, it is necessary to have relatively long periods of time. For this reason, DOB Ecology's medium-term funding was essential. Along the same lines, it was necessary to adapt the actions to the time of the communities, to align with the local schedule and, of course, to respect their festivities.

Otherwise, it would have been difficult, if not impossible, to apply new management guidelines.

In order to achieve a socioeconomic impact that improves the quality of life of the communities, work must be done at the watershed scale. For this reason, emphasis was placed on facilitating the Laguna de los Pozuelos Biosphere Reserve Management Plan.

The link that the institutions have previously developed with the communities has served as an excellent starting point to establish with them a rich dialogue and exchange

Credits: Fundación Humedales - Wetlands International

Photographs: (Crédits Fundación Humedales - Wetlands International) of traditional and technical knowledge.

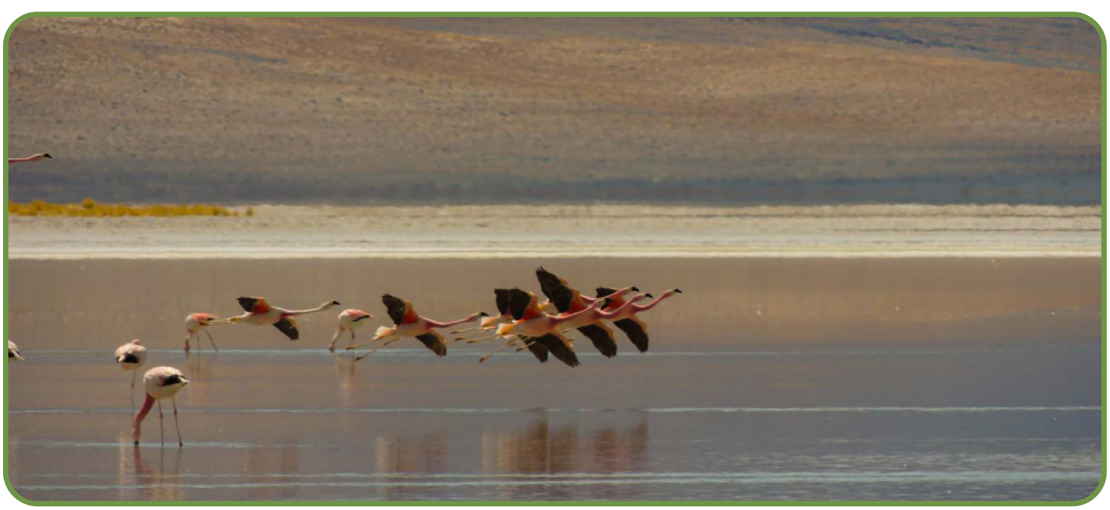
The on-line connection with the communities and local partners is very important for holding virtual meetings, given the impossibility of being present on a permanent basis, both to provide advice and to coordinate tasks in the field. Maintaining frequent contact makes it possible to maintain a fluid relationship with the communities.

Sustainability Perspectives

The program is implemented in coordination with APN, SAF, INTA, Sec. Biodiv. Jujuy, and the Corporation for the Development of the Pozuelos Basin, which makes it possible for the proposals to be institutionalized. Likewise, within the framework of the cooperation agreements with MAyDS and Sec. Biodiv. Jujuy, it seeks to promote actions of common interest.

The inclusion of the grazing management plan that was developed and validated with local communities and partners as an integral part of the Laguna de Pozuelos Biosphere Reserve Management Plan of the MaB program, UNESCO, offers an important framework for the implementation of the guidelines in the long term.

Similarly, wetland restoration tasks are carried out in conjunction with community members, which after the end of the program can be adapted to new needs with the knowledge shared at the site, also with the support of local institutions.



Credits: Fundación Humedales - Wetlands International

Photographs: (Crédits Fundación Humedales - Wetlands International)

CONCLUSIONS

Due to the importance of high Andean wetlands (HAW) for their multiple ecosystem services, their endemism and the fundamental role they play in the hydrology of the Andean region, as well as their vulnerability to climatic and non-climatic agents, conservation is presented as a priority management strategy.

This document has presented some ideas and recommendations on policies and social participation that should be considered for the conservation and management of these important ecosystems. Then, general guidelines are presented so that decision-makers, technical personnel and those responsible for planning and management of HAW can identify the necessary processes to be considered for adequate restoration. In addition, restoration practices are presented, with examples of HAW applications that, when planned in an integrated manner and with prior knowledge of the functioning of each site, can contribute to reestablishing ecosystem functions, including the recovery of its hydrological regime, vegetation and habitat. Finally, very diverse conservation and restoration experiences were compiled in each country. In some localities, policies and working groups are being formed to propose conservation sites, while in others the study areas are being characterized, and in others, successful results of the implementation of restoration practices have already been observed. In any case, all the experiences are guided by the objectives of the Ramsar Convention and the Action Plan for HAW Strategies towards conservation, restoration and sustainable use.

The implementation of hydrological restoration practices (e.g. ditch blocking and construction of small dams) found in the proposals and experiences in this document have resulted in common benefits, such as an increase in the amount of water in the wetlands, which has been achieved by being able to retain available water longer during the rainy season, avoiding extended droughts. In addition, some practices have reduced erosion in soils that have lost vegetation cover due to degradation. Other practices led to habitat improvement. All of them have allowed the passive restoration of vegetation. Active restoration on more degraded sites was necessary and also led to a reestablishment of the functions of the HAW. Monitoring during all planning and implementation processes is an important support phase to characterize intervention sites and to consider the effectiveness of practices.

This document presents multiple practices for the conservation and restoration of HAW, contributing to the strengthening of the capacities of technicians, researchers, decision makers and other actors involved in the subject. However, the challenges for the implementation of conservation and restoration practices in HAW are mainly found in the lack of governmental attention that leads to the lack of clear policies, poor management and lack of financing; as well as the deficient coordination between the different sectors involved in HAW management, which inhibits the inclusion of their experiences during the creation of policies.

The next steps that should be taken in this area are to prevent restoration, giving priority to conservation; to encourage and finance studies to determine degraded sites in order to initiate restoration actions; to pay attention to the restoration measures that are chosen and to carry out adequate monitoring so that the solutions are long-term; and to create policies and action plans focused on the individuality of communities and ecosystems.

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