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Experiences of Ecological and Participatory Wetland Restoration in the Guanacache Lagoons in the Cuyo Region of Argentina

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This article presents the results of ecological restoration actions with the participation of native Huarpe communities in the Ramsar Site " Lagoons of Guanacache, Desaguadero and Bebedero" in the province of Mendoza, in the Cuyo region of Argentina. Since 2011, the project has been working with local people to restore the wetlands in the area. In order to accumulate rainwater as a filling source and trap sediment to recover the old lagoon bottoms degraded by erosion, hydraulic structures were designed, embankments with clayey material, surfaced and suitably fixed to the lateral ravines of the gullies intervened. A total of 14 restoration projects were built in different degraded areas of lagoons and marshes associated with the Desaguadero River. With these interventions, some 1000 ha of wetlands are being restored, which has contributed to improve the associated biodiversity and to recover ecosystem services, such as access to fresh water and improved grazing for livestock production, the main economic activity of the local community. Thanks to this initiative, some 300 families living in the area have benefited in environmental and economic terms.

INTRODUCTION

According to globally available data, just over 35% of the world's wetlands are known to have been lost since 1970 to date, at a rate three times the rate of forest loss[1]. As reported at the 12th Conference of the Parties to the Convention on Wetlands in Punta del Este, Uruguay, in 2015, the global extent of wetlands declined by 64-71% in the 20th century[2].

This reduction has had a direct impact on the biodiversity of wetlands, with an estimated 81% decline in the abundance of freshwater species since 1970, a greater percentage than that experienced by other types of ecosystems[3].

It is for this reason that wetland restoration has become a necessity to conserve wetland biodiversity[4]. Ecological restoration comprises a range of activities in a variety of contexts, in some cases allowing the recovery of ecosystems that are indistinguishable from natural systems, and in others only the recovery of specific attributes or functions[5].

The Guanacache lagoons are located in Central-Western Argentina, in the Cuyo Region, at the foot of the Central Andes, between 32°12 "S - 67°30'W and 33°57' S - 66°39' W. This area belongs to the Central Montane Wetlands Region[6] and is crossed by the Desaguadero River Basin, considered the largest fully developed area within the Argentine territor[7]. The climate is temperate arid continental with regional average rainfall of less than 300 mm and an average temperature of approximately 15º C[8] (Figure 1).

The lagoons are part of the Ramsar Site "Lagunas de Guanacache, Desaguadero y del Bebedero" and cover a total area of 962,370 ha.[9]. Their wetlands are formed at the confluence of the Mendoza and San Juan rivers and the outflows of the Bermejo river[10]. Seasonal inputs from the Layes-Tulumaya system (Mendoza) and the Agua river (San Juan) shape what was once the lacustrine environment, giving rise to the Desaguadero river [11].

Today, the lagoons are in continuous deterioration, which is part of a long process of desiccation that has been going on for about 200 years [12]. At the beginning of the 20th century, they were considered to have been lost due to lack of water[13] as a result of the development of irrigated oases for agricultural purposes in their main catchment area[14].

One of the causes of the deterioration of the system is the loss of hydromorphic soils due to backward erosion caused by landslides and floods that occur after heavy summer rains, a situation that substantially modifies the structure of the basins of the main wetlands of the Ramsar Site. The channelling of watercourses leads to an increase in the velocity of surface flows[15], favouring water erosion and the development of gullies in the main receptors[16] (Figure 2).

All these changes have led to a significant reduction in the area of wetlands, affecting biodiversity and the traditional activities of their inhabitants. The communities living in the site today reclaim the wetlands as part of their culture; to recover the pastures, farming techniques, fishing, and handicrafts, among other productive activities that have been lost over time[15].

During the baseline studies in Lagunas de Guanacache, carried out for the prospection of the wetland restoration projects, more than 150 erosion gullies were surveyed, these being gullies up to 10 metres deep located in sectors where these wetlands used to exist.

The involvement of the local communities in this project is of paramount importance for its development, and in turn has generated a process that has directly benefited the local stakeholders. In recent years there has been a greater tendency to promote the participation of communities and citizens in

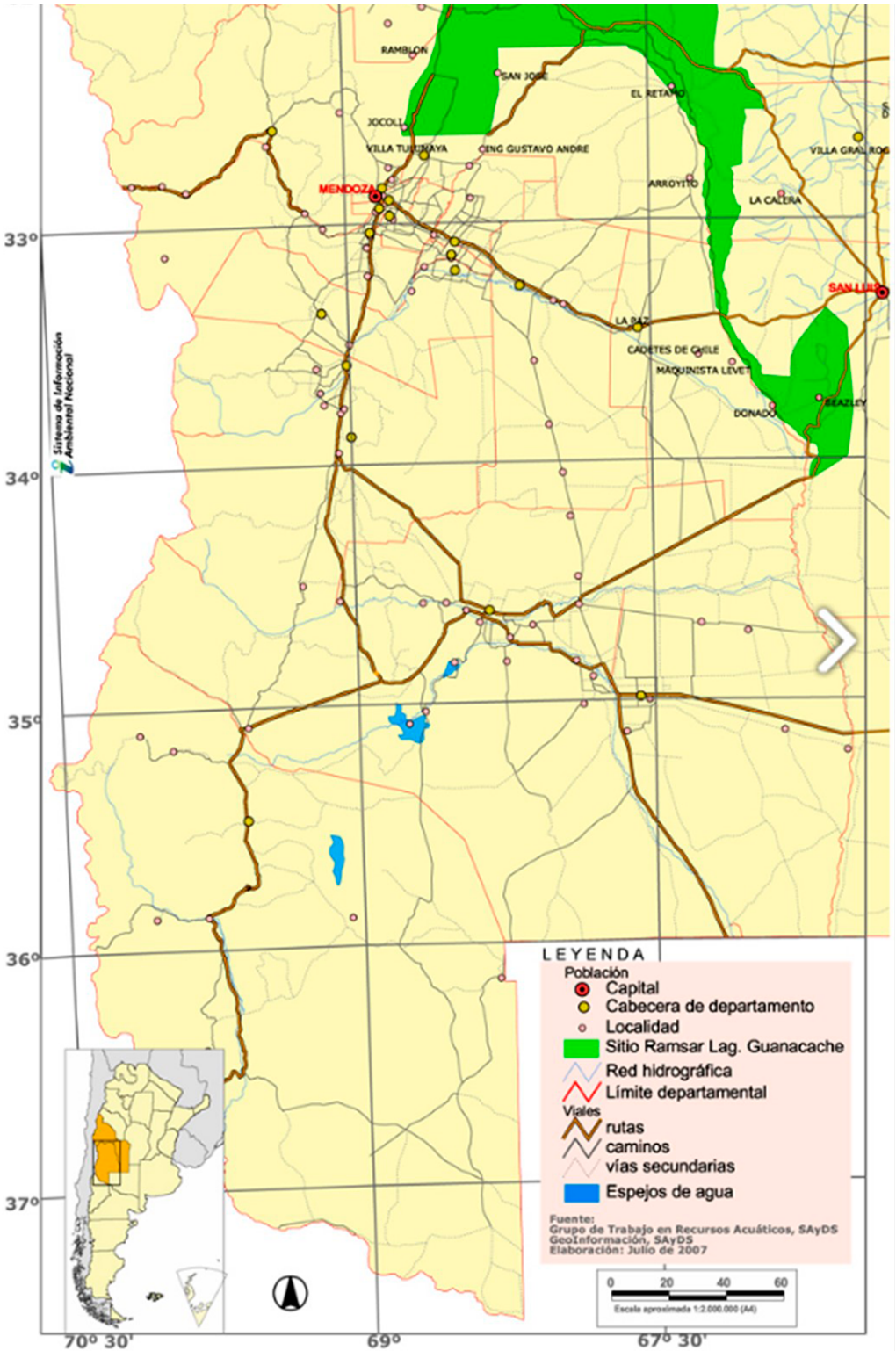
1 Ramsar, 2018
2 Davidson, 2014; Ramsar 2018
3 Quintana, 2020
4 Stevens et al., 2003; Taft et al., 2002
5 National Research Council, 2001; Zedler, 2000
6 Kandus et al. ,2017
7 Bereciartua et al. ,2009
8 Sosa & Guevara, 2017
9 Sosa, 2007
10 Torres, 2015
11 García Llorca & Cahiza, 2007
12 Hernández & Chiavazza, 2009
13 Marzo & Arias, 1975
14 Abraham & Prieto, 1981
15 Sosa & Amaya, 2015
16 Ulaco & Funes, 2006; Sosa & Amaya, 2015

development programmes that improve their well-being[17], and this project is a demonstration of the benefits of participatory processes.

Although the participatory approach may require more time for the formulation of comprehensive proposals since it requires meetings and workshops, this project is inclined towards participatory restoration where the villagers (livestock farmers) are involved from the drafting of the project based on their needs, to the monitoring for the control of the projects once they have been completed.

This paper presents the results of 10 years of ecological restoration actions in wetlands of the Ramsar Site with social participation, aiming at the recovery of their ecological character and the improvement of ecosystem services for the direct benefit of local families.

17 Norton, 2004



01 Location of the Ramsar Site in the Region of Cuyo, Argentina

01

MATERIALS AND METHODS

The actions were carried out within the framework of the Restoration and Conservation of the Ramsar Site of the Lagoons of Guanacache, Desaguadero and Bebedero, implemented by Fundación Humedales/ Wetlands International together with the local community (Huarpe native communities) with the financial support of Fundación Vida Silvestre Argentina (at the beginning of the project) and later of Fundación Avina, in an uninterrupted period of 10 years from 2011 to 2020.

A total of 35 workshops were held in the different communities belonging to the Ramsar Site, and agreement meetings were held with local authorities. It was possible to work with a sufficient number of leaders or representatives in order to ensure and validate the decisions taken through the signing of minutes.

The workshops were open to the communities, and the group meetings for each activity were convened only for the beneficiaries, who permanently supervised each action developed in the restoration process. In order to confirm the places to intervene, field trips were carried out in the company of livestock farmers, representatives and technicians, indicating the potential benefits and disadvantages of each place.

Representatives of governmental institutions (provincial and municipal) participated in different instances to ensure dialogue with the villagers and to strengthen the possibility of permanent management.

Ecological restoration methods were applied, taking into account technical documents (Ramsar 1999, 2002, 2012, 2012, 2013, 2015 and 2018) and recommendations from SER (Society for Ecological Restoration) (2004), and following the principles and guidelines of the International Union for Conservation of Nature (IUCN)[18].

For the restoration projects, embankments of different sizes were constructed according to the type of wetland to be intervened. The work sectors were georeferenced, taking into account gully sections and longitudinal slopes, together with geometric parameters. The embankments were raised with a backhoe using local materials, suitably compacted (clayey sediments) and lined with geotextile panels fixed to the ground with 50 mm x 6 mm iron stakes[19] in order to collect rainwater and act as "water and sediment traps"[20].

After the rainy period (January and February), calculations of accumulated water (in volume) were carried out. For this purpose it was necessary to record the height of the water level reached in the embankment and to measure the length of the fill upstream of the embankment. Accurate rainfall information is not available in the area, so it was necessary to rely on external sources[21] to obtain rainfall data for the area, which are estimated based on cloud refractance from satellite images. To verify the biodiversity response, birds were selected following the parameters established by Paracuellos & Tellería[22]. Indicators of bird richness and abundance were measured using 500 m transects in the sectors affected by the restoration works, with seasonal frequency from 2015 to 2019.

To visualise changes in the vegetation surrounding the works, LandSat - OLI sensor satellite images from 14 April 2013 and 17 April 2020 were used. Digital analysis of selected scenes was applied, opting for the Normalised Difference Vegetation Index NDVI, which makes it possible to estimate and identify the quality, quantity and development of the vegetation[23].

18 Keenleyside et al., 2014
19 Sosa, et al., 2012
20 Vich and Gudiño 2010, Sosa, et al., 2012
21 www.accuweather.com
22 Paracuellos and Tellería, 2004
23 Arboit and Maglione, 2018

02

02 Gully formation due to backward erosion. Guanacache 2007 (Photo: H. Paradella)

03

03 “La Pasarela” Project with accumulated water after the rainy period of 2018

RESULTS

From March 2012 to March 2020, a total of 9,141,216 m3 of rainwater accumulated in the restoration works sectors, distributed gradually over 9 years of operation. The first three works were constructed during the spring of 2011 and by the summer of 2012 they were operational (with the capacity to collect rainwater). The remaining works were constructed gradually, bringing the total to 14 completed works by 2018 (Figure 4). The accumulation of rainwater on construction sites depended on two factors: 1- the amount of millimetres of rainfall during the season and 2- the sector where the rain fell.

In 2012, rainfall was sufficient to accumulate water in the 3 works built up to that time, containing a total volume of 51,194 m3. In 2013, with a total of 6 works constructed, water was collected in only 4 of them, with a total accumulated volume of 800,604 m3. The following year the rainfall was not enough to accumulate more than a quarter of the water accumulated in the previous year.

In 2015, 1,113,399 m3 of rainwater accumulated in 8 of the 9 works built for that year. For the years 2016 and 2017 the rainfall was more localised and in relation to the previous year, the accumulation was higher considering that only 5 and 4 works operated with a total of 847,218 m3 and 1,123,713 m3 respectively.

By 2018, all 14 restoration works had been constructed at the Ramsar Site. 2018 was the record year for rainwater harvesting, with 9 works accumulating a total volume of 2,930,045 m3. In the following years 2019 and 2020 the accumulation of water decreased. Surprisingly, in 2020, with a total of 10 works in operation, they only managed to accumulate a total volume of 347,619 m3 (Figure 4).

The filling period begins with the first rains (December-January) and ends with heavier rainfall events, generally in February-March. The moments of filling (total or partial) of each reservoir depend on the local rainfall. Similarly, the accumulated volume of water is the result of the millimetres of rainfall, the water runoff in the sector and the amount of rainfall during the season (Figure 6).

Larger works tend to keep the water accumulated for longer, completing an annual cycle. In the case of the largest works (e.g. La Pasarela), in the summer season of 2018 it accumulated a maximum of 1,760,000 m3, and the water in the reservoir lasted from one year to the next (Figure 3).

Year	Number of works built	Number of works with water	Water accumulated (m^2)
2012	3	3	51.194
2013	6	4	800.604
2014		4	261.600
2015	9	8	1.113.399
2016		5	846.218
2017		4	1.123.713
2018	14	9	2.930.045
2019		9	1.665.824
2020		9	347.619

04

Projects	Max accumulate d x work (m^2)	Peak year
Pasarela	1758572.80	2018
Puertita	204997.00	2018
Chayito	39100.00	2014
Pedernales 1 & 2	32785.00	2018
Padernal 3	6253.20	2015
Camperito	6940.80	2020
Sepultura	2821.5	2015
Caballos 1 & 2	53798.00	2018
Las Marias	245273	2019
Pozo Alambrado	7407	2019
Pichanilla	642000.00	2018

05

04 Restoration works constructed in the different years of the project and their performance in terms of rainwater accumulation in m^3

05 Table of restoration projects (with their local names) showing the years of maximum rainfall accumulation in m^3

AFFECTED SURFACE AREA

With the operation of the 14 projects, some 1000 hectares of wetlands (former lagoon and marsh bottoms) and related surrounding environments (hydrophilic vegetation communities and Prosopis flexuosa woodland) are in the process of being restored (Figure 6).

ACCUMULATED SEDIMENT

The deposition of solid material in the water accumulation zone is produced by the summer sediment dragging from the feeding basin, depending on the intensity of the rainfall, the slopes, the degree of compaction of the natural collectors and the type of terrain[24]. Accumulated sediment was measured by means of fixed point recordings and yardsticks placed in the field. Of the total of 6 sites measured, an average of 0.96 m. of accumulated sediment was obtained, with a maximum value of 2 m. in 8 years of site operation (Figure 7).

BIRD RESPONSE

A total of 85 bird species, belonging to 15 orders and 27 families, were recorded in the restoration sectors. Of these, 60 species were terrestrial, 23 aquatic and 2 related to wetlands. The first species to appear in 2015 were the ducks Anas georgica, Anas bahamensis and Oxuira vittata, the common shelduck Vanellus chilensis, the plover Tringa melanoleuca, the common moorhen Fulica leucoptera and the thick-billed maca, Podilimbus podiceps. The rest of the waterfowl species were added in the following years to complete the richness of 23 species recorded until the summer of 2019, always depending on the presence of water in the works (Figure 8).

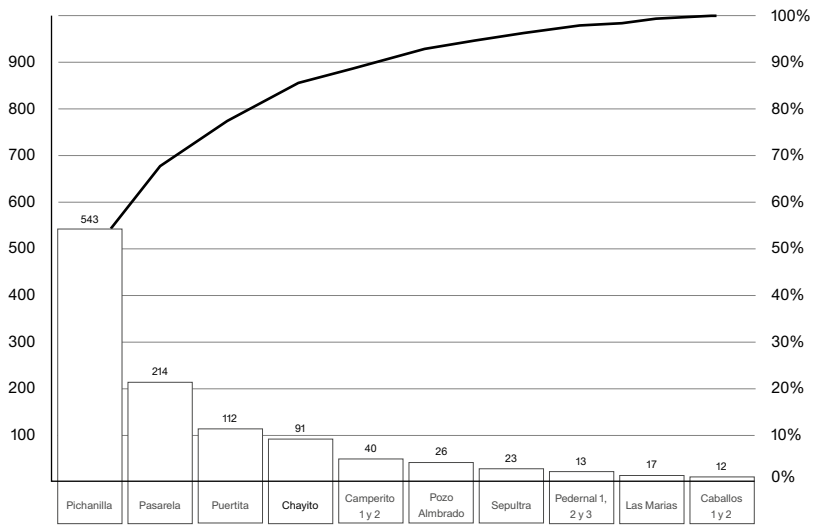
COMPARATIVE ANALYSIS OF SATELLITE IMAGES

According to the distribution of NDVI values in the sector under analysis (La Pasarela construction site), it can be observed that the statistical ranges of the minimum and maximum values of the index have increased between 2013 (Figure 9) and 2020 (Figure 11)

In relation to the behaviour of the NDVI index, the average value increased slightly (0.020) in the period between 2013 and 2020. This value is sufficient to see the change in the surrounding vegetation with the naked eye (Figures 10 & 12)

In the workshops and meetings held in the field, a good level of representation was achieved thanks to the commitment of community leaders and livestock farmers to the project by working on the projects and subsequent adjustments (Figure 13). Through the participation of the state government, the institutional strengthening and management capacity of the communities was achieved. The network of institutions and organisations related to the project and the territory was expanded (Figure 14).

24 Casaño et al.; 1998



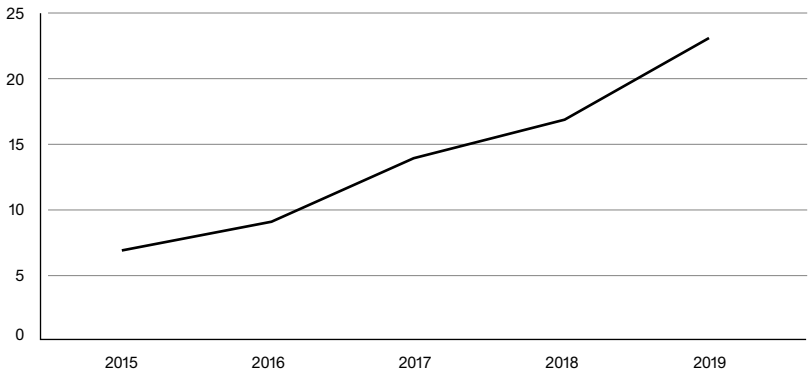
06

06 Graph of the surface area covered by water of each restoration project and its area of impact on surrounding environments

Obra	Sedimento acumulado (m)	Tiempo en anos
Pasarela	2	8
La Puertita	1	8
Padermal 1	0.8	6
El Chayito	0.6	7
Padernal 2	0.4	6

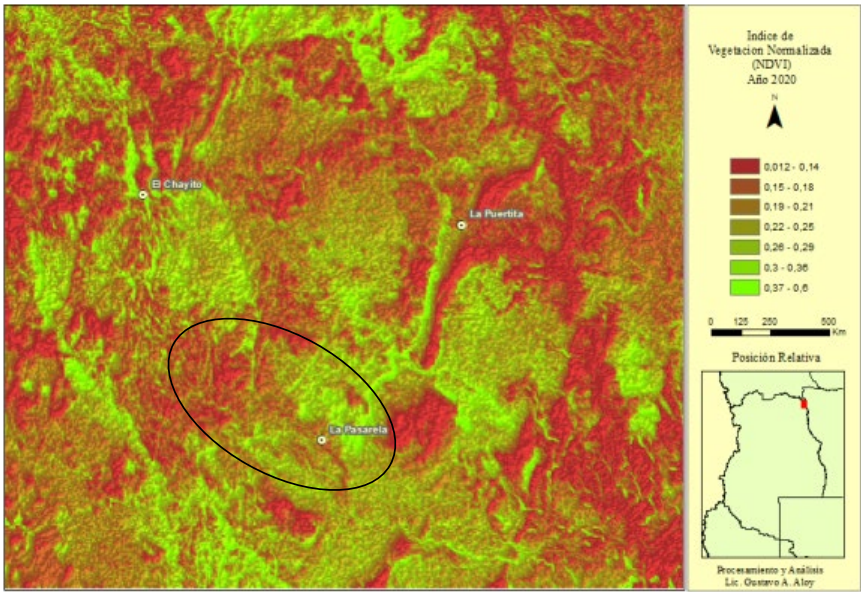
07

07 Sediment accumulated in projects with measurements



08

08 Waterbird richness at restoration sites over time.

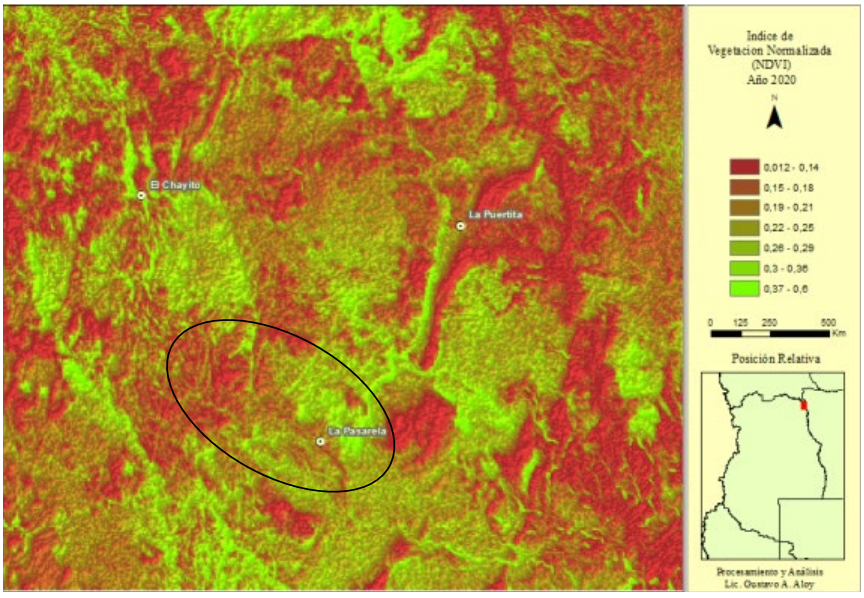


09

09 Image from 2013. La Pasarela project sector (projects in operation for 2 years)

10

10 La Pasarela project in March 2013 (circled on map). Photo on the left shows the environment upstream of the construction site. Photo on the right shows the construction site



11

11 Image from 2020. La Pasarela project sector, El Retamo (project in operation for 9 years)

12

12 La Pasarela project in March 2020 (circled on map). Photo on the left shows the environment upstream of the construction site. Photo on the right shows the construction site

13

13 Workshops in the field with local livestock farmers. Actions were decided in the field

14

14 Workshops with technicians and local institutions in which community representatives also participated.

CONCLUSIONS

This project demonstrates that it is possible to initiate a process of wetland restoration by using rainwater as a source and retaining sediment in erosion gullies, through the construction of works with local material and the use of new technologies such as the use of geotextile membrane as a protective liner.

With the restoration process underway and the works in operation it was possible to accumulate up to 4 hm3 of rainwater in a good rainy period. Much of this water can remain in the system until the next summer period.

With the accumulation of water in the works, it was possible to retain up to 2 metres of sediment. This material, deposited at the bottom of the gullies, contributes to the recovery of the eroded soil. This raises the base levels of the gullies to their original levels.

The effect caused by the accumulation of water and sediment over nine years in 14 constructed projects, contribute to initiate a passive restoration process in an area of just over 1000 ha. of wetlands and surrounding environments.

This is reflected in the positive response of the bird community and in the passive recovery of vegetation as expressed in the green index analysis through satellite imagery.

At social level, some 300 families of livestock farmers benefited directly, whose animals benefit from water accumulated in intervened areas and natural pastures strengthened thanks to the operation of the restoration works.

With regard to community participation and project ownership strategies, the following has been achieved: 1) Improving the capacity for self-management before the relevant institutions to address the maintenance of works; 2) Incorporating the issue of wetlands and their need for restoration in assemblies; 3) Increasing interest in managing funding for projects related to access to water. 3) Increased interest in the management of financing for projects related to access to water.

REFERENCE

Abraham, E. & M. Prieto (1981). Enfoque diacrónico de los cambios ecológicos y de las ad

s secos. Boletín de Estudios Geográficos N°09, febrero – junio 2018, pp. 13 – 60.

Bereciartua, P., N. Antunez, L. Manzelli, P. Lopez, A. Callau Poduje, S. Ludueña & S. Flores (2009). Estudio integral de la Cuenca del río Desaguadero-Salado-Chadileuvú-Cuacó-Colorado. Facultad de Ingeniería. Universidad de Buenos Aires. Tomo I.

Davidson, N. (2014). How much wetland has the world lost? Long-term and recent trends in global wetland area. Marine and Freshwater Research, 65 (10): 934–941.

García Llorca, J. & P. Cahiza (2007). Aprovechamiento de los recursos faunísticos en las lagunas de Guanacache (Mendoza, Argentina). Análisis zooarqueológico de la Empozada y Altos de Mellen II. Chungará Vol. 39 (1): 117-133.

Hernández. F. & H. Chiavazza (2009). Aportes de la Geografía y la Arqueología para el análisis de las transformaciones en el humedal de Lagunas del Noreste Mendocino. Revista Geográfica Digital. IGUNNE. Facultad de Humanidades, UNNE Año 6. N.º 12. Junio-diciembre 2009. Resistencia Chaco.

Kandus, P. P. Minotti, I. Fabricante Y C. Ramonell (2017). Identificación y delimitación de Regiones de Humedales de Argentina, pp.: 33-46. En BLANCO, D. R. BO, P. KANDUS, G. LINGUA, P. MINOTTI Y R. QUINTANA (editores) 2017. Regiones de Humedales de la Argentina. Ministerio de Ambiente y Desarrollo Sustentable. Fundación Humedales/ Wetlands International. Universidad Nacional de San Martín y Universidad de Buenos Aires.

Keenleyside, K.A., N. Dudley, S. Cairns, C.M. Hall & S. Stolton (2014). Restauración Ecológica para Áreas Protegidas: Principios, directrices y buenas prácticas. IUCN, Gland, Switzerland. 118 pp.

Marzo, M. & H. Arias (1975). Ríos del Sistema Hidrográfico Andino. Geografía de la República Argentina. Tomo VII 2º parte. Hidrografía. Sociedad Argentina de Estudios Geográficos. Buenos Aires.

NATIONAL RESEARCH COUNCIL (2001). Compensating for wetland losses under the Clean Water Act. National Academy Press, Washington

Norton, R. (2004) Política de desarrollo agrícola. Conceptos y principios. Organización de las Naciones Unidas para la Agricultura y la Alimentación. Rome 2004.

Paracuellos M. & J. Tellería (2004). Factors Affecting the distribution of a waterbird comunity: the role of habitat configuration and bird abundance. Waterbirds 27(4): 446- 453.

Quintana, R (2020) Una mirada a la ecología y al estado de los humedales N° 9 Ambiente 2 páginas https://www.argentina.gob.ar/noticias/la-ecologia-y-el-estado-de-los-humedales

RAMSAR (1999). Marco para evaluar el riesgo en humedales. Resolución VII.10. VII Reunión de la Conferencia de las Partes Contratantes de la Convención sobre los Humedales. San José, Costa Rica.

RAMSAR (2002). Principios y lineamientos para la restauración de humedales. Resolución VIII.16. "Humedales: agua, vida y cultura" 8a Reunión de la Conferencia de las Partes Contratantes en la Convención sobre los Humedales (Ramsar, Irán, 1971) Valencia, Spain.

RAMSAR (2012). Los beneficios de la restauración de humedales. Nota Informativa. GECT. Convención sobre los Humedales (Ramsar, Irán, 1971). 22 pp.

RAMSAR (2013). The Ramsar Convention Manual, 6th edition. Ramsar Convention Secretariat, Rue Mauverney 28 CH-1196, Gland, Switzerland. 30 pp.

RAMSAR (2015). Una Alianza Mundial para la Restauración de los Humedales. Resumen del concepto, Convención sobre los Humedales (Ramsar, Iran, 1971).

RAMSAR (2018). Perspectiva mundial sobre los humedales: Estado de los humedales del mundo y sus servicios a las personas. Gland (Switzerland). Secretaría de la Convención de Ramsar

Salinas Acosta A., R. Rodríguez Quirós, D. Morales Hidalgo (2010). Manual de especificaciones técnicas básicas para la elaboración de estructuras de captación de agua de lluvia en el sector agropecuario de Costa Rica y recomendaciones para su utilización (SCALL) / Documento: D-O6. Nicoya: Universidad Nacional, CEMEDE.

SER (2004). Society for EWcological Restoration International, Grupo de trabajo sobre ciencia y políticas. Principios de SER International sobre la restauración ecológica Versión 2. www.ser.org y Tucson: Society for Ecological Restoration International.

SOSA H. (2007). Propuesta de ampliación del Sitio Ramsar. Nueva denominación Sitio Ramsar Lagunas de Guanacache, Desaguadero y del Bebedero. Ficha Informativa de los Humedales de Ramsar (FIR) Versión 2006-2008. 23 pp.

Sosa, H. N. Amaya & N. Ovando (2012). Restauración y Conservación del Sitio Ramsar Lagunas de Guanacache, Desaguadero y del Desaguadero. 1ª ed. Buenos Aires: Fundación para la Conservación y el Uso Sustentable de los Humedales 2012. 64 pp.

Sosa, H. & N. Amaya (2015). Restauración ecológica participativa de humedales en el sitio Ramsar Lagunas de Guanacache, Desaguadero y del Bebedero, Mendoza, Argentina. En: Martínez Carretero, E. & A. Dalmasso (Eds.) Restauración Ecológica en la Diagonal Árida de la Argentina. 484 pp. 1a ed.

Sosa, H & B. Guevara (2017). Región Humedales del Monte Central pp.: 195 – 204. En BLANCO, D. R. BO, P. KANDUS, G. LINGUA, P. MINOTTI Y R. QUINTANA (editores) 2017. Regiones de Humedales de la Argentina. Ministerio de Ambiente y Desarrollo Sustentable. Fundación Humedales/Wetlands International. Universidad Nacional de San Martín y Universidad de Buenos Aires.

Stevens, C., T. Gabor & A. Diamond (2003). Use of restored small wetlands by breeding waterfowl in Prince Edward Island, Canada. Restoration Ecology, Vol. 11, 1:3-12.

Taft, O., M. Colwell, C. Isola & R. Safran (2002). Waterbird responses to experimental drawdown: implications for the multispecies management of wetland mosaics. Jour. Appl. Ecol. 39: 987-1001.

Torres, E. (2015). Hidrología del río Desaguadero Cap. Nº2 :43-60. En: Rodríguez Salas, A. (Ed.) Restauración de un sistema ecológico compartido. Estudio ambiental del Sitio Ramsar Laguna de Guanacache, Desaguadero y del Bebedero. Ed. DUNKEN, Buenos Aires.

Ulaco, H. & N. Funes (2006). Estudios de Humedales del Centro Oeste de San Luis. Anexo 1: Informe botánico y ecológico. Flora, fauna y características ecológicas. Área Guanacache y Salinas del Bebedero. Universidad de San Luis.

Vich, A. & M. López Rodríguez (2010). Estrategias de mitigación y control de amenazas naturales en áreas de piedemonte. En: Vich, A. & M. Gudiño (Eds.). Amenazas naturales de origen hídrico en el centro-oeste árido de Argentina. Diagnóstico y estrategia para su mitigación y control en el Gran San Juan y Gran Mendoza. Cap. 19: 393-424. Ed. Fundación Universidad de San Juan, ZETA Editores 433 pp.

Zedler, J. & J. Callaway (2000). Evaluating the progress of engineered tidal wetlands. Ecological Engineering 5: 211-225.

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