Chapter 20
Conflict Areas and Solution Strategies in the Conservation of Ecosystems and Their Services: A Holistic Approach

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Abstract Natural environments and biodiversity are negatively affected by climate change and non-sustainable human activities around the world. Different management strategies have been implemented to mitigate the loss of habitat and ecosystem functions. Nevertheless, many of these have failed because, in general, they focus on protected areas. The loss of habitat and, thus, biodiversity occurs outside these areas and does not receive attention. Often, the conservation strategies go against the needs of the communities in the surroundings of the protected areas, generating a series of conflicts between the local governments, conservationists, and residents. In this sense, it is necessary to carry out holistic conservation strategies that consider human beings and their socio-cultural complexity within the environment to overcome the effect of climate change on biodiversity loss. This chapter empirically shows how it is possible to apply conservation strategies integrating scientific and political capacities and uniting governmental and non-governmental organizations for the execution of socio-environmental, educational, and research actions. This holistic approach contributes to the restoration of the environment and its services and to the mitigation of climate change in subtropical regions.

Keyword Atlantic forest · Non-protected areas · Holistic model · Policy makers · Biodiversity hotspot

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20.1 Background

Climate change is a phenomenon that has occurred naturally since the beginning of the planet's history; however, during the last century, there is abundant scientific evidence that suggests that certain human activities accelerate change (Mcmichael et al., 2004). These activities are typically related to the emission of greenhouse gases (through the action of industry and agriculture) and the progressive loss of environments, especially forests, which fix these gases such as carbon dioxide (Díaz, 2019; Mcmichael et al., 2004). Forests are transformed into pastures for livestock or are unsustainably exploited, resulting in the degradation and loss of habitats, as well as the ecosystem services that they provide to humanity (Laurance, 2010). Climate change and habitat loss are currently the major causes for the worldwide decline of biodiversity (Brook et al. 2008; Serengil et al., 2011). Habitat fragmentation, conversion, and overexploitation are the leading drivers of biodiversity decline and species extinctions in tropical hotspots (Norman, 2003). Some actions have been implemented in an attempt to mitigate the loss of habitats, such as the creation of specific legally protected areas (PA) (e.g. National Parks) and World Heritage sites (Gray et al., 2016). This concept of creating legally protected areas that preserve samples of specific environments (e.g. vulnerable hotspots) has been used throughout the world (Norman, 2003). There is no doubt that PAs help to conserve environments, which is reflected in the conservation of biodiversity, ensure certain ecosystem services, and contribute to mitigating climate change. However, legally PAs commonly represent a small proportion of the ecosystems they intend to protect (Norman, 2003), and research efforts are often focused only on them (Oldekop et al., 2016), leaving aside legally non-protected areas (NPAs), which are more likely to disappear (Avigliano et al., 2019a). Moreover, many management policies, and even a significant amount of research, are focused on these small PAs (Ferro et al., 2014; Lemes et al., 2014; Loyola et al., 2014; Massara et al., 2015; Paschoal et al., 2016); meanwhile, habitat loss occurs on a large scale outside them. Conservation based solely on Strict Nature Reserves (prohibited access) that often exclude some needs of societies (e.g. refuge, and access to natural resources) generates conflict between different actors such as states, conservationists, and the local population (Lewis, 1996). These conflicts threaten the efficiency of conservation plans because different sectors of society are excluded from them. Currently, we know that conservation based on PAs is not enough to protect the habitats necessary to conserve biodiversity, ensure ecosystem services, and mitigate climate change (Avigliano et al., 2019a). It is necessary to change the paradigm and apply strategies combining legally PAs (e.g. strict nature reserves) with areas of multiple and sustainable use, including society and its needs in conservation and management plans (Oldekop et al., 2016). Considering the wealth of evidence on the importance of NPAs in maintaining ecosystem services and mitigating their exposure to human activities (DeFries et al., 2007; Palomo et al., 2013), greater efforts must be made to conserve and properly manage these areas. The management of NPAs is especially complex because they are typically multipurpose areas and often correspond to a

mixture of public and private lots that are subject to different uses and are inhabited by diverse ethnic groups with different relationships with nature (Papalia, 2012). In this sense, conservation actions cannot focus only on inspection, control, research, and, occasionally, environmental education (predominant activities in protected areas) but must go hand in hand with strategies for sustainable use and restoration of biodiversity. To carry out these actions, it is necessary to address different spheres, integrating population, government agencies (ministries, local, provincial, and national governments), scientists, non-governmental organizations, and access to financing from different sources (state, international, private) (Oldekop et al., 2016).

Herein, we present our experience, in which we reveal the importance of an unprotected semi-degraded area from the southern extreme of the Atlantic Rainforest (ARF), which can help provide further tools for sustainable management of biodiversity and environment conservation in NPAs. We have applied a holistic approach, integrating basic research on biodiversity, direct restoration actions, social, educational, and outreach actions, and interactions with different political, scientific, and educational organizations.

20.2 Methods

20.2.1 A Holistic Approach Model

Society uses semi-degraded non-protected areas as part of their economies, culture, and recreation. Consistently, local policy makers should take the community values and characteristics into account in the design and promotion of management plans. This case study transcends the purely conservationist concept by developing a holistic approach (Fig. 20.1) to support ecosystem services, nature conservation, and sustainable development. This approach is the result of the interaction between

Fig. 20.1 Schematic representation of the holistic approach to the management and recovery of ecosystem services, conservation, and sustainable development in the study area. *Note*. All bubbles are closely interrelated through the holistic approach. (*Source*: Prepared by the authors)

different spheres of actors and interactions between national, international, private, and governmental institutions.

20.2.2 Atlantic Rainforest

With 1500,000 km^2, the ARF represents one of the main biodiversity hotspots in the world (Norman, 2003) and functions as an important climate shaper (Ledru et al., 2009). It is among the main hotspots with the largest number of endemic plants and vertebrates, amounting to 4.8% of total endemic species on the planet (Norman, 2003). Currently, less than 8% of the original cover remains, principally as small fragments (<50 ha) that are isolated from each other (Ribeiro et al., 2009). More than 110 million people live across the ARF, including colonists of European descent and several Mbyá-Guaraní indigenous groups (~135,000 inhabitants) (Leal et al., 2003; Ribeiro et al., 2011). Forest is commonly replaced by agriculture and livestock pasture, silvopastoral systems, and urban areas at a deforestation rate of 200 km^2/year (INPE, 2015). There are more than 650 PAs in the ARF, with a total surface area of 14,000 km^2, representing only 1% of the original area (Leal et al., 2003).

Therefore, it could be anticipated that semi-degraded non-protected areas from the ARF could be very valuable for the conservation of neotropical habitats, so management efforts should not be concentrated only on PAs. In this context, we have located our holistic management efforts in a semi-degraded non-protected area of the ARF. This area is a 650 ha private parcel where there are no permanent inhabitants. The area borders with farms of 25–50 ha inhabited by single families, which have tobacco, tea, and yerba crops, and a private and uninhabited parcel of semi-degraded forest of around 5000 ha (private property). There are two urbanized centres, with less than 1500 inhabitants each, less than 8 km away.

20.2.3 Legal Framework

The Fundacion Bosques Nativos Argentinos para la Biodiversidad (FBNA) is a non-profit, non-governmental organization (NGO) that provides a formal framework for management and conservation actions; it was formalized between 2009 and 2011 by local people and scientists. In terms of a legal framework, the study area (650 ha owned by FBNA) is based on private land without strict restrictions, unlike national parks or other protected natural areas. The main legal instrument concerning land use in the study area is the National Law on Minimum Standards for Environmental Protection of Native Forests (National Forest Law, 26, 331, 2007). This regulation promotes the enrichment, restoration, conservation, and rational and sustainable use of native forests and their ecosystem services.

20.2.4 Identifying Problems That Need To Be Addressed

From 2010, the FBNA brought together a series of specialists from different areas of knowledge, local producers, and people to carry out environmental baselines and identify management problems and priorities (Table 20.1). Scientific research was promoted and facilitated on the NPA by building a scientific station named "Centro de Investigations Antonia Ramos (CIAR)" within the study area. CIAR has accommodation for 16 researchers distributed in two cabins, a laboratory, and terrestrial and aquatic vehicles. Issues about education, communication, and sustainable production were explored through ad hoc interviews and workshops with the local community (Table 20.1).

20.3 Partial Results

20.3.1 Financing

Given the nature of the holistic approach to developing alternatives for preserving natural areas with no legal protection within a climate change context, the financial strategy was open and broad (Table 20.1). The first step was taken by local landlords with high environmental awareness to develop the master plan and the first in-field capacities to obtain clear results in a short time. These results and the master plan were key factors for fundraising. The funding sources were broad and were relevant to all stakeholders to reflect a common goal and common outcomes. Mainstreaming biodiversity and climate change in the project can lead to UNEP-UNDP-GEF funding and other sources of international financing, such as the International Barcode of Life Program (iBOL), national forest funding (National Forest Law), National Science Agency funding, provincial funding, individual donors through the NGO, and private sector.

As an outcome of the financial approach, the GEF-UNDP funding (2016–2018), and multi-stakeholder involvement, an ecosystem services payment scheme was developed to protect the local watershed, encouraging good management practices in local farms.

20.3.2 Scientific Research

Since 2010, we have invited scientists to carry out environmental (bacteriological, pharmaceutical, physicochemical, and agrochemicals studies, among others) and taxonomic (e.g. mammals, birds, arthropods, fish, and fungi) studies in order to generate baselines that facilitate decision-making on the management of the area (Table 20.1). Scientists have carried out their research with the logistical support of

Table 20.1 Summary of the main results obtained through the different activities

Activity	Mechanism	Date	Result
Financing	Constant presentation of financing projects at the local, provincial, national and international levels	2009–present	Acquisition of funds from different sources, for example, International Barcode of Life Program (2013–2014), UNDP-UNEP-GEF 3623; UNDP-GEFARG15/G53: 2016–2018, national forest funding (2011 and 2014), National Science Agency funding (several projects), provincial funding (several projects), and donations
Scientific research	Creation of the CIAR	2010	Biodiversity baseline
	Presentation of financing projects at the local, provincial, national and international levels	2010–present	Pollution baseline
			Peer-reviewed scientific publications
Forest restoration	Workshops and interviews with local inhabitants	2010–2015	Creation and maintenance of a seed bank
	Presentation of financing projects at different scales	2010–present	Creation of plant nurseries (40,000 seedlings/year)
	Identify and differentiate the seedbeds	2010–present	165,000 native trees (plant cover increased 38%)
			Implementation of several river bank recovery projects
Education and communication	Workshops and interviews with local inhabitants and rulers	2010–present	Built a primary level school (2013) involving the local population (around 270 students/year graduated)
	Presentation of financing projects at different scales	2010–present	Implementation of several educative projects (e.g. slingshot project)
	Creation and maintenance of websites and social networks	2011–present	Educational talks from primary to postgraduate
	Creation and maintenance of the biodiversity magazine	2011	Creation of the annual postgraduate course “dynamic biodiversity restoration” (2017)
			Permanent interaction through networks with more than 350,000 followers

(continued)

Table 20.1 (continued)

Activity	Mechanism	Date	Result
Sustainable production	Workshops and interviews with local inhabitants and rulers	2010–present	Creation of sustainable production samples at CIAR
	Presentation of financing projects at different scales	2012–present	Assistance and workshops for local producers and students of different educational levels
			Implementation of several strengthening, training and transfer projects
Policy makers	Permanent work with local and national rulers through workshops and interviews	2011–present	New environmental legislation: e.g. law XVI-116 (2016)
			Support for the creation of the Instituto Misionero de Biodiversidad

Note: Prepared by the authors

CIAR and, in many cases, have published their results in indexed journals (Avigliano et al., 2019a).

20.3.2.1 Biodiversity Baseline

Relatively high specific richness was found in most of the taxa examined, and one new genus (arachnid) and six new species and several putative new species (fish and arthropod) were described (Avigliano et al., 2019a). In addition, six vulnerable species (bird and mammal) and 36 first records for Argentina (fish, arthropod, platyhelminth, and fungi) were reported (Avigliano et al., 2019a). Among the most emblematic and globally vulnerable species, the red brocket deer, *Mazama nana*, the feline *Leopardus tigrinus*, and the helmeted woodpecker, *Celeus galeatus,* were reordered. The DNA of more than 70,000 terrestrial arthropods was studied, and 8,651 different barcode index numbers (which are a close proxy for species) were found. The total number of species of diurnal butterflies found around the CIAR was 500, representing around 70% of the species found in the Iguazú National Park and 25% of the species recorded in the whole ARF, indicating that the CIAR and its surroundings are a butterfly hotspot for the entire ecoregion (Avigliano et al., 2019a).

20.3.2.2 Pollution Baseline

Up to 18 organochlorine pesticides were measured in water, suspended particulate matter, sediment, epiphytic plants, and fish (Avigliano et al., 2019a; Ondarza et al., 2019). Caffeine, norfluoxetine (a metabolite of the antidepressant fluoxetine),

benzoylecgonine, and antibiotics were detected in the tissues of three native fish species (Ondarza et al., 2019). The concentration of 20 trace elements, glyphosate, and fecal coliform in surface water have been explored in the CIAR (Avigliano et al., 2019a, b; Avigliano & Schenone, 2015).

20.3.2.3 Forest Restoration

In the last 50 years, selective deforestation (extraction of wood) has affected 85% of the study area, while the remaining 15% was totally deforested (Avigliano et al., 2019a). Tobacco, tea, and yerba mate were cultivated inside the study area. In order to mitigate this scenario, reforestation projects have been implemented as part of the biodiversity restoration master plan. These projects included activities such as the creation and maintenance of a seed bank, construction and maintenance of nurseries, and planting and monitoring (Table 20.1). The first action was a series of workshops and interviews with local inhabitants, many of whom live off the extraction of wood, to identify the highly impacted species. The second action was to identify and differentiate the seedbeds with the support of the local community. Later, plant nurseries of 50 native tree species were built. Finally, annual plantations and monitoring were carried out in the context of different subprojects. FBNA personnel, local residents, and school-age children (see education and communication section) invest in these plantations. Over the last decade, around 165,000 trees have been planted using different methodologies according to the characteristics of the terrain and the degree of deterioration of the forest. Among the main results, we observe that the intermediate stratum (10–20 m) is recovering and, in the most conserved patches of forest, the canopy stratum (20–30 m), the herbaceous and shrub layer was managed to guarantee access to light for seedlings (Avigliano et al., 2019a). After a decade of work, plant cover increased 38%, at an average rate of 3.8% per year (Avigliano et al., 2019a).

Several reforestation projects were associated with the recovery of riverbanks (e.g. Acaraguá River, Ramón, Ramos, and Cascada streams) to mitigate the effect of runoff caused by deforestation and trampling of livestock. These projects need a holistic approach because they must be accompanied by mitigation actions that allow farm animals access to water but not to riverbanks (see financing section). In this sense, electrified fences powered by renewable energy must be built, and reforestation, monitoring of environmental parameters, protection of water springs, and management of pastures and livestock are also required.

20.3.3 Education and Communication

Education and outreach (Table 20.1) were essential to integrate local communities into management projects. The local communities belong to vulnerable settlements, and many people do not have the means to travel to schools. Therefore, the FBNA

built a primary level school on the outskirts of the study area, which is attended by 270 students. The school was built by local people, including parents of the students, which created a feeling of belonging. The students frequently attend lectures and environmental activities (actively participate in the plantations) codified by FBNA staff and teachers.

Various educational projects have been implemented and supported, such as the "slingshot project", in which cycles of talks were held in 16 public schools with more than 100 teachers and attended by more than 1,000 students (2014–2015). The exchange of slingshots for binoculars was used as an opportunity to give educational talks on conservation and environmental management.

At the university level, educational talks and examples of case studies are given in national universities and educational institutes such as museums throughout the country. Since 2017, the postgraduate course "Dynamic Biodiversity Restoration" has been taught, to which more than 400 students are enrolled per edition. Many students carry out their bachelor, master, and doctoral thesis studies on different environmental topics.

The FBNA interacts permanently with its followers through the official website (www.bosques.org.ar n.d.) and social networks such as Instagram and Facebook (www.facebook.com/BosquesNativosArgentinos n.d.). From the beginning, the FBNA has published a free environmental outreach magazine called Biodiversity® (www.bosques.org.ar/publicaciones/ n.d.). Restoration and management actions are also communicated through radio, television, and documentary interviews on a local and national scale.

20.3.4 Sustainable Production

The effectiveness of NPAs as units for the conservation of ecosystem services depends, at least in part, on considering the needs of the local population. In this sense, it is necessary to generate tools that allow the inhabitants to obtain an economic benefit from the services provided by the environment they care for (Table 20.1). CIAR functions as a pilot and experimentation site to generate sustainable production tools and has solar yerba dryers, native bee hives, lots planted with native fruit trees, and yerba mate under the forest, as well as facilities to produce food based on native fruits for educational purposes. Part of the energy used (lighting, irrigation systems, and water distribution for animal drinkers) is based on solar and hydro energy as a demonstration of production based on reduced carbon signatures.

The projects associated with educational and outreach activities seek to produce high-quality organic food within the forest while enriching the forest with native arboreal species at the same time. Other projects aim to replace the afforestation of exotic trees with native fruit trees, which produce food that can be marketed in different ways. For example, from 2020–present, a project (PNUD ARG 15/G53) has been carried out in which a cooperative of women producers were trained to

produce native fruit trees and products derived from fruits. A series of field trainings were carried out, four nurseries were built, and private lots were afforested with thousands of native fruit trees.

20.3.5 Policy Makers

The relationship with the local government was part of the strategy to capitalize on the results obtained by the pilot project and improve environmental legislation (Table 20.1). This step was started at the beginning of the process to create a bond between environmental results and political results in a synergic way. The relationship and the fluid information exchange with the local authorities put the environmental concern on the provincial political agenda. New environmental legislation was developed to replicate the pilot model at a provincial scale, and the provincial biodiversity institute (Instituto Misionero de Biodiversidad, IMIBIO) was created for these purposes by law (Law XVI-122) in 2018 (https://imibio.misiones.gob.ar/ n.d). For example, the provincial germplasm law was issued (Law XVI-116) as a result of the holistic model. We have also generated a water quality monitoring manual and a large number of technical documents for specific problems according to the requirements of the provincial managers (Schenone et al., 2014).

20.4 Discussion and Final Remarks

Protecting specific heritage areas and protected areas is crucial, but still not enough to mitigate climate change, conserve biodiversity, and maintain ecosystem services in the long term (Avigliano et al., 2019a). There have to be new ways of understanding the surrounding areas to buffer the effects of climate change in World Heritage natural areas (Gray et al., 2016). The holistic approach based on the interaction between society, science, and environmental policies and applied to the semi-degraded natural pilot site yielded valuable contributions for the integral management of these areas, supporting the restoration of the environment and its services and the mitigation of climate change.

The absence of long-term financing plans and communication and dissemination strategies for management in other natural areas excludes the local community from any possibility of contributing to the management and conservation plans. This is observed in several Multipurpose Protected Areas such as the Yabotí (YBR) and Delta del Paraná (DPBR) Biosphere Reserves. A clear example is the deterioration of both reserve's biological stations, caused by lack of funding and lack of long-term scientific policies. Usually, new knowledge about these areas depends on the will of scientists who carry out specific investigations (Avigliano et al., 2016; Rolón et al., 2021), which are not integrated into a management plan. A large part of the DPBR community does not know what activities are allowed or the benefits of the

protected area (Cassini & Túnez, 2019). Therefore, people do not have the tools to integrate with and contribute to management strategies.

In this study, the suitability of the approach used is reflected in the success of reforestation, education and communication activities, research, and economic support to local communities through the execution of projects associated with sustainable production (Table 20.1). The success of this project was also reflected in the creation of a provincial research and management institute (IMIBIO). This institute is based in Iguazú city (located 220 km from CIAR), which has been a biodiversity hotspot and World Heritage property since 1984, and was established to scale up the holistic approach carried out in our pilot site.

The activities carried out during the decade of work resulted in a map of interactions, supported by a series of scientific investigations (Avigliano et al., 2019a), which was essential to generate conservation and management actions (Fig. 20.2). The progress of the projects was communicated at local, national, and international community scales through the scientific community or through environmental education projects. The resulting communications and the scientific evidence contribute to the updating of environmental laws and policies, the action of which requires the interaction between different institutions such as an NGO (FBNA) and local and national governments. Throughout the process, specific funds were required for the different actions (Table 20.1), which were mainstreamed through the FBNA. All these actions added together resulted in the execution of projects for conservation and active restoration of the environment, leading to the implementation of sustainable production models and contributing to regional economies. Finally, the holistic approach was able to provide an important range of ecosystem services and thus contribute to the mitigation of climate change.

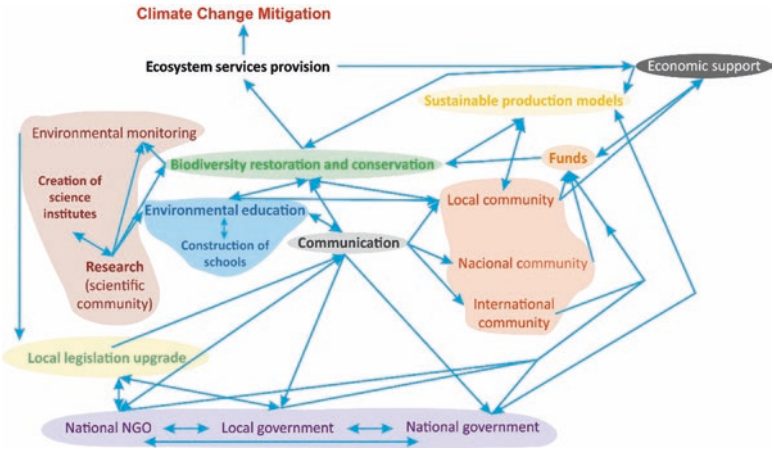

Fig. 20.2 Map of interactions between different actors and work areas carried out to generate holistic conservation and management actions. (*Note*: Prepared by the authors)

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