Application of the Restoration Barometer in Mexico

Progress of ecosystem restoration from 2011 to 2020

Jesús Hernández-Castán, José Avendaño, Eduardo Cuesta-Mejía, Carmen López, Tony Nello and Silvio Simonit

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

GITEC-IGIP Consulting Group

About IUCN

IUCN is a membership Union uniquely composed of both government and civil society organisations. It provides public, private and non-governmental organisations with the knowledge and tools that enable human progress, economic development and nature conservation to take place together.

Created in 1948, IUCN is now the world's largest and most diverse environmental network, harnessing the knowledge, resources and reach of more than 1,400 Member organisations and around 15,000 experts. It is a leading provider of conservation data, assessments and analysis. Its broad membership enables IUCN to fill the role of incubator and trusted repository of best practices, tools and international standards.

IUCN provides a neutral space in which diverse stakeholders including governments, NGOs, scientists, businesses, local communities, indigenous peoples organisations and others can work together to forge and implement solutions to environmental challenges and achieve sustainable development.

Working with many partners and supporters, IUCN implements a large and diverse portfolio of conservation projects worldwide. Combining the latest science with the traditional knowledge of local communities, these projects work to reverse habitat loss, restore ecosystems and improve people's well-being.

https://www.iucn.org
https://twitter.com/IUCN/

Application of the Restoration Barometer in Mexico

Progress of ecosystem restoration from 2011 to 2020

Jesús Hernández-Castán, José Avendaño, Eduardo Cuesta-Mejía, Carmen López, Tony Nello and Silvio Simonit

IUCN is pleased to acknowledge the support of its Framework Partners who provide core funding: Ministry of Foreign Affairs, Denmark; Ministry for Foreign Affairs, Finland; Government of France and the French Development Agency (AFD); Ministry of Environment, Republic of Korea; Ministry of the Environment, Climate and Sustainable Development, Grand Duchy of Luxembourg; the Norwegian Agency for Development Cooperation (Norad); the Swedish International Development Cooperation Agency (Sida); the Swiss Agency for Development and Cooperation (SDC) and the United States Department of State.

IUCN and the other participating organisations claim no responsibility for errors or omissions that may occur in the translation into English of this document whose original version is Spanish. In the case of discrepancies, please refer to the original edition. Title of the original edition: Aplicación del Barómetro de la Restauración en México. Progreso de la restauración de ecosistemas durante la década 2011-2020. (2022). Published by: IUCN, Gland, Switzerland. This publication has been made possible through the generosity of IKI-BMU; through the project: "Restoration Barometer," financed by German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMU).

Published by:	IUCN, Gland, Switzerland
Produced by:	IUCN, Regional Office for Mexico, Central America, and the Caribbean (ORMACC)
Copyright:	© 2022 IUCN, International Union for Conservation of Nature and Natural Resources
	© 2022 IUCN International Union for Conservation of Nature and Natural Resources for the English translation.
	Reproduction of this publication for educational and non-commercial purposes is authorized without prior written permission from the copyright holder, provided the source is acknowledged.
	Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.
Recommended citation:	Hernández-Castán J., Avendaño, J., Cuesta-Mejía E., López C., Nello, T. y Simonit, S. (2022). *Application of the Restoration Barometer in Mexico. Progress of ecosystem restoration from 2011 to 2020*. Gland, Switzerland: IUCN.
Design and layout:	Marta Lucía Gómez Zuluaga
Technical Revision:	Tania Ammour (IUCN-ORMACC) and Leander Raes (UICN Economics Team)
Translated by:	Veraly Morales
Cover photo:	© Erick Ecker

Content

Tables and figures

Tables

Figures

Executive summary

Starting in 2016, IUCN with the support of the German Federal Ministry for the Environment (BMU) and the Climate Initiative (IKI) has developed the Restoration Barometer (originally launched as the Bonn Challenge Barometer) to support governments in tracking progress towards restoration targets across terrestrial ecosystems[1]. It tracks the size of the area being restored, as well as the corresponding climate, biodiversity and socioeconomic benefits. It also covers the enabling policies and financing structures at the heart of successful restoration. It provides an opportunity for national and subnational governments to simplify and streamline reporting on their restoration commitments. It can help track and record progress towards global targets. These include the UN Decade of Ecosystem Restoration, the Paris Agreement and the Land Degradation Neutrality target.

This report presents the results of applying the Restoration Barometer in Mexico, considering the particularities of the national context, data availability and the methodological guidelines provided by the Barometer guide for governments[2]. The Regional Office for Mexico, Central America and the Caribbean of the International Union for Conservation of Nature (IUCN ORMACC) carried out this analysis in collaboration with the National Forest Commission (CONAFOR).

This publication aims to make known the actions and impacts associated with the advances of the United Mexican States towards the restoration commitments acquired within the framework of the Bonn Challenge. Likewise, it generates useful information to continue and optimize investment and restoration planning processes in the country as part of the United Nations Decade on Ecosystem Restoration. As part of the Bonn Challenge, Mexico's commitment is to restore 8,468,280 hectares (ha) by 2030.

The application of the Barometer in Mexico shows the state of the art of enabling activities such as planning, monitoring, restoration financing, restored areas, and their effect on job creation, conservation of endemic and/or endangered species and mitigation of climate change.

1 Dave et al. (2018). *Second Bonn Challenge Progress Repor*t. Available at: https://doi.org/10.2305/IUCN.CH.2019.06.en

2 Restoration Barometer, A Guide for Governments, International Union for Conservation of Nature. Available in: https://restorationbarometer.org/

The main messages that stand out from this application at the national level are:

- Restoration in Mexico advanced substantially in the decade 2011–2020, with an estimated 5,219,986 ha restored, representing 61% of the national target set as part of the Bonn Challenge.
- Considering the 493,826 restoration activities identified, it stands out that restoration in Mexico is multiform, with 27 different types of restorative actions implemented, and relatively well distributed throughout Mexico, having occurred in more than 80% of the country's municipalities.
- Although for 85% of the restoration activities (i.e., number of projects) the agroforestry modality is reported, when considering the areas of land restored, it is the restoration of forest ecosystems that predominates: with natural regeneration (44%), silviculture (23%) and conservation of forest lands and resources (11%), while agroforestry systems represent 20% of the intervened area. This trend could indicate that the restoration of agricultural areas is generally implemented on a smaller scale per project compared to forest restoration.
- There is a need to standardize the restoration registration format among various institutions, including the collection of cartographic data that allows precise georeferencing of the information: only one fifth of the registered area (806,126 ha) has spatially explicit boundaries.
- The main source of investment for restoration in Mexico comes from public funds from the federal government, which has invested MXN60,911,159,022 (USD2,834,395,487, value as of 2020) over the decade analyzed, equivalent to 5% of the budget allocated for environmental protection in the country.
- With respect to employment generation, due to the characteristics of restoration actions, these generate casual jobs, which were estimated at 1,822,491, giving an average of 0.35 jobs per hectare.
- There is a modest impact on climate change mitigation during the decade 2011–2020 (3.9M. TCO_2e) compared to the extension of the georeferenced restored areas (806,126 ha).
- It was identified that the species that benefited most in terms of habitat improvement or creation were the transvolcanic rattlesnake (*Crotalus triseriatus*) and the zacatuche rabbit (*Romerolagus diazi*), as well as the habitats of 32 species prioritized by the country were improved. About a third of these species are endemic and a little more than half are in danger of extinction.
- Restoration has contributed to the recovery and protection of areas of high biodiversity, with 10% of the explicit area located in Key Biodiversity Areas and 22% in natural protected areas.

Acknowledgements

The IUCN expresses its gratitude to those who contributed to the application of the Restoration Barometer in Mexico by providing access and guidance regarding actions and organizations involved in restoration processes: SEMARNAT, Ministry of Agriculture and Rural Development, CONAFOR, CONAZA, CONANP, CONABIO, AMERE; DUMAC, Mexican Fund for the Conservation of Nature AC, Reforestamos México A.C., WRI México.

Acronyms

ADFS	Support Program for Sustainable Forestry Development
AMERE	Mexican Alliance for the Restoration of Ecosystems
CBD	Convention on Biological Diversity
CCMSS	Mexican Civil Council for Sustainable Forestry
CONABIO	National Commission for the Knowledge and Use of Biodiversity
CONAFOR	National Forest Commission
CONANP	National Commission of Natural Protected Areas
CONAPO	National Population Council
CONAZA	National Commission of Arid Zones
CONEVAL	National Council for the Evaluation of Social Development Policy
COUSSA	Conservation Works and Sustainable Use of Soil and Water
CPI	Consumer's Price Index
CSOs	Civil society organizations
CUSTF	Environmental Compensation for Land Use Change in Forest Land
DECOFOS	Southern States Forest Community Development Project
DOF	Official Gazette of the Federation
DUMAC	Ducks Unlimited Mexico
ENRR	National River Restoration Strategy
FAO	Food and Agriculture Organization of the United Nations
FFM	Mexican Forest Fund
FLR	Forest landscape restoration
FMCN	Mexican Fund for the Conservation of Nature
GDP	Gross domestic product
GIC	GITEC IGIP Consulting group
GSPC	World Strategy for the Conservation of Plant Species
ID	Unique Identifiers
ILO	International Labour Organization
INE	National Institute of Ecology
INECC	National Institute of Ecology and Climate Change
INEGI	National Institute of Statistic and Geography
ITTA	International Tropical Timber Agreement
IUCN	International Union for Conservation of Nature
KBA	Key Areas for Biodiversity Conservation
LAN	National Water Law
LDRS	Sustainable Rural Development Law
LFRA	Federal Environmental Responsibility Law
PESL	Special Program for the Conservation, Restoration and Sustainable Use of the Lacandona Jungle
LGCC	General Law on Climate Change
LGEEPA	General Law of Ecological Balance and Environmental Protection
LGVS	General Wildlife Law
NDC	Nationally Determined Contributions
NGO	Non-governmental organizations
NOM	Official Mexican Standards

PACE	Conservation Action Program
PEPY	Special Program for the Conservation, Restoration and Sustainable Management of the Forest Resources of the Yucatan Peninsula
PESA	Strategic Food Security Project
PND	National Development Plan
POH	Small Hydraulic Works
PROÁRBOL	Program for commercial forest plantations
PROCODES	Conservation Program for Sustainable Development
PROCOREF	Ecosystem Conservation and Restoration Program
PROCYMAF	Project for the Conservation and Management of Forest Resources in Mexico
PRODEFOR	Forest Development Program
PRODEZA	Strategic Project for the Development of Arid Zones
PROFEPA	Federal Attorney for Environmental Protection
PROFOS	Program for the Promotion of Social Organization Planning and Regional Forestry Development
PROMARNAT	Environment and Natural Resources Sector Program
PRONAFOR	National Forest Program
PRONARE	National Reforestation Program
PROREST	Program for the Protection and Restoration of Ecosystems and Priority Species
REDD+	Reducing Emissions from Deforestation and Forest Degradation
REPARA	Mexican Network for Environmental Restoration
RFM	Forest Restoration of Micro-basins and Strategic Regions
SADER	Secretariat of Agriculture and Rural Development
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food
SARH	Secretariat of Agriculture, Livestock and Hydraulic Resources
SDG	Sustainable Development Goals
SEDENA	Secretary of National Defense
SEDESOL	Ministry of Social Development
SEMARNAP	Secretariat of the Environment, Natural Resources and Fisheries
SEMARNAT	Secretary of Environment and Natural Resources
SEP	Secretary of Public Education
SINANP	National System of Protected Natural Areas
SOC	Soil organic carbon
UMA	Management Units for the Conservation of Wildlife
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Research Institute
WWF	World Wide Fund for Nature
ZRE	Ecological Restoration Zones

Introduction

The restoration of ecosystems or landscapes in Mexico began in the last century when, in the 1920s and 1940s, the importance of forests and Basins was recognized for their role in capturing water. The Mexican government promotes restoration actions aimed at reforestation. The first restoration actions created a regulatory framework with the definition of responsible institutions. Furthermore, Mexico is committed to various international agreements directly or indirectly linked to restoring ecosystems.

One of Mexico's international agreements in 2014 is the Bonn Challenge, launched in September 2011 during a ministerial act organized by the Government of Germany and the International Union for Conservation of Nature (IUCN), which was expanded through the 2014 New York Declaration on Forests. The initiative represents a global effort to restore 150 million hectares (Mha) of forests by 2020 and 350 million hectares by 2030, based on the forest landscape restoration (FLR) approach.

The Bonn Challenge is a voluntary, non-binding initiative that seeks to drive a restoration movement and recognize the importance of forest landscape restoration to meet national priorities and international commitments. By 2022, a total of 74 entities from 61 countries, 8 states, and 5 associations have committed to contributing to the goal of restoring more than 210 Mha within the framework of the Bonn Challenge (Bonn Challenge, 2021). Likewise, it is an excellent opportunity to improve social and environmental results on a global, national and subnational scale; also contributing to the fulfillment of the Aichi goals of the Convention on Biological Diversity, the REDD+ objective (Reduction of Emissions from Deforestation and Forest Degradation), of the United Nations Framework Convention on Climate Change, the Objective of United Nations Land Degradation Neutrality, the United Nations Sustainable Development Goals regarding the global goals for forests.

Starting in 2016, IUCN, with the support of the German Federal Ministry for the Environment (BMU) and the Climate Initiative (IKI), has developed the Restoration Barometer (launched initially as the Bonn Challenge Barometer) to support governments in tracking progress toward restoration targets across all terrestrial ecosystems. Beyond monitoring restored areas to report on their progress, this tool highlights which actions are working and why and reveals obstacles to scaling up the scope of restoration. Additionally, it provides a simplified way to streamline the contribution reports of restoration actions towards global goals (e.g., Post-2020 Global Biodiversity Framework).

In Mexico, the Restoration Barometer piloting began in 2018 for the state of Quintana Roo, and was scaled up to a national level in 2021.

This technical report summarizes the results of applying the Restoration Barometer nationally in Mexico. An analysis of the information referring to the restoration comprised in the decade from 2011 to 2020 was performed.

It should be emphasized that the analysis of the restoration was based on readily accessible information generated by public institutions related to the subject in Mexico and, to a lesser extent, provided by Civil Society Organizations. The analysis accounts for the different restoration actions developed in the country, their contribution by the Mexican government, the intervened surface of the main ecosystems, and the investment made in these, as well as the sources of financing.

The analysis provided information on the participation of indigenous groups, men and women. It also reported the temporary and permanent jobs generated by the restoration actions. Similarly, it was identified to what extent the restoration has been directed to municipalities in conditions of poverty or vulnerability to climate change.

Another variable analyzed is the capture of CO_2 through restoration. Finally, public policies were analyzed as an enabling factor for restoration in Mexico.

1 Restoration in the international context

Definition

Ecosystem restoration means preventing, halting and reversing the degradation of ecosystems worldwide to regain their ecological functionality and improve productivity and capacity to meet the needs of society. It is an umbrella term referring to a range of restorative actions that change the human footprint within and across ecosystems, rather than removing that footprint all together. Conservation and environmental protection (actions to reduce the degradation of land, water, and ecological support systems) are implicitly included in ecosystem restoration (IUCN, 2022).

Restoration, as the discipline we know today, has decades of history, being the creation of the *Society for Ecological Restoration* (SER) in 1987, a world reference and turning point (Mazón & Gutiérrez, 2016).

Recently, in Latin America, different national networks have joined in Mexico, Brazil, Cuba, Argentina, and Chile. Also, in 2013, the Ibero-American and Caribbean Society for Ecological Restoration was formed, based in Bogotá (Echeverría, 2015).

In Mexico, restoration is a concept that has been used since the first Forest Law of 1926 (INECC, 2007), which also regulated the conservation, propagation, and use of forests and their resources (CCMSS, 2022). However, its meaning and context have changed considerably over the years.

Restoration indicators and reports for the goals of international commitments

The review of Mexico's various agreements and treaties shows that restoration actions indirectly impacted at least 5 of these, with specific, direct contributions to the Bonn Challenge, the 20X20 initiative, and the United Nations Decade for Restoration of Ecosystems. See Table 1.

Table 1 Main treaties and agreements and their relationship with restoration

AGREEMENT/ TREATY	Commitment	Relationship with restoration actions
United Nations Framework Convention on Climate Change UNFCCC (1992)	As part of the Paris Agreement, the established goal contemplates the unconditional reduction of 51% of the volume of its emissions by the year 2030, taking as a reference a trend scenario lacking measures to combat climate change.	One of the tools against Climate Change has been the reforestation and restoration of ecosystems, so quantifying these actions and their contribution to reducing emissions is vital to fulfilling the established commitment. Mexico's contribution is ambitious and includes, among many other actions: Being the first country to develop and apply a General Law on Climate Change (2012), which proposes to reduce by 50% all polluting emissions by 2050 compared to those in 2000.
Convention on Biological Diversity (1992)	Mexican Strategy for Plant Conservation (EMCV)	It was directly related to the restoration of ecosystems, especially those focused on managing native species. When Mexico signed the Convention on Biological Diversity (CBD) in 1992 and ratified it in 1993, it acquired an international commitment to conserve and promote the sustainable use of its biodiversity.
	AICHI Goals (2010) 5. By 2020, the loss rate of all-natural habitats, including forests, will be at least halved and, where feasible, reduced to near zero and significantly reduce degradation and fragmentation. 7. By 2020, areas used for agriculture, aquaculture, and silviculture will be managed sustainably, ensuring the conservation of biological diversity. 9. By 2020, invasive exotic species and pathways had been identified and prioritized, priority species had been controlled or eradicated, and measures were established to prevent their introduction and establishment. 11. By 2020, at least 17 % of terrestrial and inland water areas and 10 percent of marine and coastal areas, mainly those critical to biodiversity and ecosystem services, are conserved. This is done through effective and equitable management and ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures. These measures are integrated into the broader landscapes and seascapes. 12. By 2020, the extinction of identified endangered species will have been prevented, and their conservation status enhanced and sustained, especially for the most declining species. 13. By 2020, the genetic diversity of cultivated plant species, farmed and domesticated animals, and related wild species, including other species of socio-economic and cultural value, is maintained, and strategies have been developed and implemented to minimize genetic erosion and safeguard their genetic diversity. 14. By 2020, ecosystems that provide essential services, including water-related services, and that contribute to health, livelihoods, and well-being, have been restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable. 15. By 2020, the resilience of ecosystems and the contribution of biological diversity to carbon stocks will have been increased through conservation and restoration. At least 15 % of degraded land was restored, contributing to climate change mitigation, adaptation, and the fight against desertification.	Restoration actions have a direct or indirect impact on the conservation of biodiversity. Likewise, they reduce the pressure on areas of conserved ecosystems. Restoration actions must be quantified, particularly in all those ecosystems that provide essential ecosystem services.
United Nations Convention to Combat Desertification (1996)	Voluntary commitment (raised annually through the organizations in charge of combating desertification).	The restoration actions carried out by CONAFOR and CONAZA mainly have a regional impact on this commitment, therefore it is necessary to quantify them to know the progress in their fulfillment. Mexico will promote the establishment of concrete goals to reduce land degradation and desertification in a context of good practices for the sustainable management of agriculture and silviculture areas.

AGREEMENT/ TREATY	Commitment		Relationship with restoration actions
Global Strategy for the Conservation of Plant Species GSPC (2002)	EGCV	Goal 3. Develop and share information.	Restoration and reforestation actions with native species are important for the fulfillment of this commitment.
		Goal 5. At least 75 % of the most important areas for plant diversity in each ecological region are protected through effective management to conserve plant species and their genetic diversity.	
		Goal 7. At least 75 % of known threatened plant species are conserved in situ.	
		Goal 10. Invasive exotic species	
		Goal 12. Use of plant resources	
International Tropical Timber Agreement ITTA (2006)	Does not apply to restoration actions		
The Bonn Challenge (2011)	The voluntary agreement, 700,000 ha committed by Quintana Roo; 1,000,000 ha committed by Chiapas; and, 1,000,000 ha committed by Campeche.		The relationship is direct, and the quantification is essential to know the fulfillment of the acquired commitment.
The Bonn Challenge 20X20 Initiative (2014)	Mexico's commitment is to restore 8,468,280 ha through public programs.		Like the Bonn Challenge, restoration must be quantified to know the commitment's fulfillment.
New York Declaration on Forests (2014)	Reduce by halve the annual loss of natural forests by 2020 and strive to achieve zero deforestation by 2030		It happens just like the previous two commitments.
Agenda 2030 (2015)	ODS	Objective 1. - End of poverty	Quantify the indirect effects of conservation actions that can contribute to the fulfillment of these indicators.
		Objective 2.- Zero hunger	
		Objective 3.- Health and Well-being	
		Objective 4.- Quality education	
		Objective 5.- Gender equality	
		Objective 6.- Water and sanitation	
		Objective 9.- Industry, innovation and infrastructure	
		Objective 10.- Reduction of inequalities	
		Objective 11.- Sustainable cities and communities	
		Objective 12.- Responsible production and consumption	
		Objective 13.- Climate action	
		Objective 14.- Underwater life	
		Objective 15.- Life of terrestrial ecosystems	
		Objective 16.- Peace, justice and solid institutions	
		Objective 17.- Alliances to achieve the objectives	

AGREEMENT/ TREATY	Commitment		Relationship with restoration actions
United Nations Decade for Ecosystem Restoration (2019)	Latin America and the Caribbean Action Plan		
	Channel I. Promotion and public awareness	Action 2. Visibility to the restoration of leading ecosystems	
	Channel II. Political compromise	Action 4. Preparation of support materials for transformative leadership in ecosystem restoration	
		Action 5. Develop and implement a regional financial innovation strategy for ecosystem restoration initiatives	
	Channel III Technical Capacity	Action 8. Guarantee access to knowledge	
		Action 9. Promotion of collaboration in scientific analyzes and synthesis	
		Action 10. Training of professionals in ecosystem restoration	

Source: Own elaboration.

Indicators, guidelines and typologies used in the Restoration Barometer and the United Nations Decade for Ecosystem Restoration

The Restoration Barometer and the United Nations Decade for Ecosystem Restoration (UNEP, 2022) have generated a list of indicators, guidelines, and typologies that are considered restoration actions. The comparison of these two initiatives broadly reflects the following:

- *The United Nations Decade Initiative for Ecosystem Restoration differentiates seven types of ecosystems (Forests-Trees, Rivers-Lakes, Towns-Cities, Oceans-Coasts, Croplands-Grasslands, Mountains, and Peatlands) and the Barometer 8 (Deserts-semi-deserts, forests-woods, grasslands-shrublands-savanna, rivers-streams-lakes, peatlands, coasts-mangroves, urban areas, and agricultural-mixed use areas).*
- *The United Nations Decade Initiative for Ecosystem Restoration group croplands and grasslands under a single category while the Barometer separates grasslands, shrublands, and savannahs from agricultural and mixed-use areas.*
- *The Restoration Barometer handles specific restoration practices and uses technical language. At the same time, the United Nations Decade Initiative for Ecosystem Restoration mentions, in most cases, general activities and handles language for the general public, so general criteria were used to identify those most aligned.*
- *The Restoration Barometer leaves to the implementer's discretion the option of other restoration practices in several of the categories it handles.*

2 Historical process of restoration in Mexico

Definition of restoration in Mexico

Mexico has been carrying out actions for decade, although some were not known as restoration at the time. This can be seen from the first Forest Law of 1926 (INECC, 2007). Such a law regulated the conservation, propagation, and use of forests and their resources (CCMSS, 2022). However, its meaning and context have changed considerably.

The General Law of Ecological Balance and Environmental Protection (D*iario Oficial de la Federación*, 1988), in its article 3, section XXXIV published in 1988 and its last reform of 2018, defines restoration as "*the set of activities aimed at the recovery and continuation of the conditions that favor the evolution and continuity of natural processes*". Likewise, the General Law of Sustainable Forest Development (*Diario Oficial de la Federación*, 2018), in its article 7, section LVI published in 2018 and its last reform of 2021, defines forest restoration as a "*set of activities aimed at the rehabilitation of a forest ecosystem to recover partially or wholly its original functions*".

As for CONAFOR, its manual of practical works for the protection, restoration, and conservation of forest soils, applied since 2004, uses the following concepts:

Forest restoration. It is the set of activities to rehabilitate a degraded forest ecosystem to *partially* or wholly recover its original functions and maintain the conditions that favor its persistence and evolution.

Reforestation. Induced establishment of forest vegetation on preferably forest land or degraded forest land.

Historic development of restoration in Mexico

A review of the restoration actions was carried out, as well as the most relevant instruments for Mexico from the first Forest Law decreed in 1926 to 2009 (see annex I), and it was emphasized in the decade from 2011 to 2020 (Table 2).

Evidently Mexico has carried out both direct and indirect restoration actions since the last century and maintains them today. In 2021, the restoration actions developed by the Mexican government had been maintained in general terms and had even generated programs arguing restoration actions.

However, different actors belonging to institutions related to the restoration topic (CONABIO, CONANP, AMERE, WRI Mexico) have expressed their opinion on the need for unified and long-term policies, through which the effectiveness of interventions can be measured, as well as targeting investments for them. (See minutes of meetings in Annex II).

Table 2 Different restoration actions and regulatory instruments developed in Mexico in the decade from 2011 to 2020

YEAR	INSTRUMENT AND ACTIONS
2011	The Special Program for Coastal Basins of the State of Jalisco comes into operation, which will restore with reforestation and soil conservation activities (Agua.org, 2014), executed in five basins located in the western part of the state (CONAFOR, 2011a). Between 2011 and 2016, the Restoration Program for the upper part of the Nazas River Basin in the State of Durango took place. The Irritila Program developed it, which is part of the CONAFOR concurrent funds agreement. In 2015, the agreement was restructured to continue with the commitment to allocate the resources until 2020 (CONAFOR, 2016). The Special Program for the Conservation, Restoration and Sustainable Use of the Lacandona Forest (PESL) begins and ends in 2014 (CONABIO, 2020).
2012	The National Institute of Ecology and Climate Change (INECC) was created as a decentralized public body of the Federal Public Administration. Its purpose is to coordinate and carry out studies and scientific or technological research projects on climate change, environmental protection, and preservation and restoration of the ecological balance and provide the technical and scientific support from SEMARNAT (Cuenta Pública Hacienda Gobierno de México, 2014). Several emerging programs were launched in 2012. The Río Verde Grande Basin Restoration Program in Aguascalientes was launched with funds from CONAFOR and the State Government. The resources were applied to soil restoration, reforestation, surveillance, and exclusion in more than 470 thousand hectares that comprise the entity's 29 priority areas and 4 protected natural areas (LJF.MX, 2014). The Special Program for restoration, conservation, and community silviculture development of hydrographic micro-basins in the states of Oaxaca and Chiapas, the Program for restoration, protection, and development of the Tarahumara zone in the state of Chihuahua (CONAFOR, 2012). The Special Program for Conservation, Restoration and Sustainable Management of Forest Resources of the Yucatan Peninsula (PEPY) is implemented, supported by CONAFOR and CONABIO as technical agent, this program ends in 2014 (CONABIO, 2018).
2013	CONAZA began a process of renewal of its legal framework to be consistent with the policies and plans of the National Development Plan 2013-2018. Its mission, vision and objectives were reconsidered and modified, stating that soil conservation actions must be executed among its objectives. (Guerrero García, 2017).
2014	The National Forest Program (PRONAFOR) is published in which one of its objectives is to promote the conservation and restoration of forest ecosystems, one of the main instruments is the payment for environmental services (CONAFOR, 2012).
2015	CONABIO began the coordination process to identify Priority Sites for Restoration (SPR) for terrestrial environments in Mexico, with the collaboration of experts from different national institutions as well as from outside the country (CONABIO, 2018).
2018	The *Sembrando Vida* Program was presented, which has among its objectives to help reverse rural poverty and environmental degradation (Secretaría de Bienestar, 2020), which proposes planting timber and fruit trees.
2019	It began with the Program for the Protection and Restoration of ecosystems (POREST) in charge of national Commission of Natural Protected Areas (CONANP, 2019).
2020	Tula-Atitalaquia-Apaxco Region Restoration Program began, as part of the National Basins Restoration Plan (SEMARNAT, 2020). The Mexican Alliance for Ecosystem Restoration was created, promoted together with WWF and *Reforestamos México*, and aligned with the United Nations Decade for the Restoration of Ecosystems 2021-2030 (WRI, 2020).

Source: Own elaboration.

Regulatory framework

Restoration in Mexico has been a topic of interest for different institutions and professionals in the field. Different documents have been made where restoration work, policies, and experiences of specific cases are analyzed. Among these works are Méndez-Toribio *et al*. (2018); Ceccon and Martínez (2016); and Cedeño-Gilardi and Pérez-Salicrup (2021), where the latter make mention of different regulatory instruments involved in restoration in Mexico over different years.

The following Kelsen pyramid, elaborated by Carabias (2016), briefly describes the Mexican norms related to restoration.

The Political Constitution of the United Mexican States

The Mexican Constitution is the fundamental law of a State; it establishes the basic rights and obligations of citizens and rulers. In environmental matters, there are four basic articles related to restoration actions (articles 4, 25, 27, and 73).

Convention and international treaties

Table 1 describes the international conventions and treaties signed by Mexico.

General and sectoral laws

General Law of Ecological Balance and Environmental Protection (LGEEPA)

The LGEEPA, enacted on January 28, 1988, and enforced on March 1 of that same year, has undergone 22 modifications and is considered a framework law for environmental policy, which "incorporates into environmental legislation a holistic and systematic vision of the environment, through rules that regulate the environmental elements and effects. Like the other general laws on environmental protection and restoration of the ecological balance, the LGEEPA attempts to establish a concurrent framework for the actions of the authorities of the three levels of government in order to promote sustainable development and establish the bases for, among other elements, the preservation, restoration and improvement of the environment (Art. 1).

General Wildlife Law (LGVS)

This law was enacted in 2000. Its purpose is "the conservation and sustainable use of wildlife and its habitat in Mexican territory and areas where the Nation exercises its jurisdiction." Its specific objectives include the restoration, recovery, reproduction, repopulation, and reintroduction of species and their habitats. Within the LGVS, the Management Units for the Conservation of Wildlife (UMA) are regulated and destined to conservation in restoration zones defined in the LGDFS regulations.

Figure 1 Graphic representation of the Kelsen pyramid on the hierarchies of norms in Mexico.

Source: Taken from Carabias *et al*. 2016.

General Law on Climate Change (LGCC)

This law was enacted in 2012. In 2018 various provisions contained in this law were reformed, added and repealed. The LGCC contributes to the national implementation of the UNFCCC and its objectives include the regulation of actions for mitigation and adaptation, as well as the reduction of the vulnerability of the country's population and ecosystems to the adverse effects of climate change. In the context of the LGCC, ecosystems, forest resources and soils restoration is considered an action of both adaptation and mitigation in terms of carbon sequestration.

National Water Law (LAN)

This law has its antecedents with the Law of Waters of National Property, decreed on August 7, 1929, and in 1992 was promulgated as Law of National Waters (Universidad Autónoma de Coahuila, 2016), having its last modification in 2020. It is the normative instrument that governs the development, use, and protection of the Nation's water resources and their administration. It confirms and reinforces the role of the National Water Commission as the leading agency for the surveillance and development of the Nation's water resources and establishes the Basin Councils. These councils are instances of coordination and agreement between all interested public agencies, including water users. The Article 86 BIS 1 states that national hydraulic programming is considered as a fundamental function of the Federal Government (FAO, 2021). The "Commission" will act through the Basin Organizations or by itself to preserve wetlands affected by national water flow regimes in the cases provided for in Section IX of Article 9 of this Law. Said cases are reserved for the direct action of "the Commission."

For such purposes, it will have the following powers: I. Delimit and keep an inventory of wetlands in national assets or those flooded by national waters. II. Promote this Law and its regulations, the national water reserves or the ecological reserve under the law of the matter, for the preservation of wetlands; III. Propose the Official Mexican Norms to preserve, protect and, where appropriate, restore wetlands, the national waters that feed them, and the aquatic and hydrological ecosystems that are part of them (*Comisión Nacional del Agua*, 2021).

Sustainable Rural Development Law (LDRS)

The LDRS was published in 2001 and with its last modification in 2021. It indicates in Article 11.- Actions for sustainable rural development through infrastructure works and the promotion of economic activities, and the generation of goods and services within all productive chains in rural areas, will be carried out by criteria of preservation, restoration, sustainable use of natural resources, and biodiversity, as well as prevention and mitigation of environmental impact (*Diario Oficial de la Federación*, 2001).

Federal Environmental Responsibility Law (LFRA)

This law was enacted in 2013. It determines the reparation obligations derived from the damage caused to the environment, which includes restoring habitats, ecosystems, and environmental services to their base state through restoration, re-establishment, treatment, recovery, or remediation in the same place where damage was caused.

Official Mexican Standards (NOM)

NOMs are mandatory technical regulations that, among other purposes, establish rules and specifications to comply with environmental protection or ecosystem preservation purposes (LFMN, Art. 3, section XI and Art. 40, section X). Within the existing NOMs in environmental matters, three refer to environmental restoration, although this matter is not the specific object of said regulations:

- NOM-152-SEMARNAT-2006 that regulates forest management programs.
- NOM-060-ECOL-1994 to mitigate the adverse effects of forest exploitation.
- NOM-022-SEMARNAT-2003 that regulates coastal wetlands.

3 Public restoration policies and eligible areas

Public politics

Currently, the Mexican government institution dictating public policy on environmental matters is SEMARNAT, which implements the actions generated by said policies through its different institutions and agencies. The institution in Mexico that carries out restoration actions within its mandate is CONAFOR, which is why it has support programs to inject resources into the country to carry out restoration actions. CONANP, as part of SEMARNAT, also has programs directed in this line but limited to protected natural areas.

In addition, other institutions of the Mexican government belonging to different sectors have carried out actions during the decade from 2011 to 2020 on restoration issues, such as the Agriculture secretariat through CONAZA and the Welfare secretariat through the program *Sembrando Vida.*

CONAFOR

The National Forest Commission (CONAFOR) is a Decentralized Public Organization of SEMARNAT founded on April 4, 2001. It supports and promotes the conservation of forests, jungles, wetlands, and arid and semi-arid zones. CONAFOR also fights to recover forest areas that undergo weather phenomena, forest fires, the presence of pests, and diseases. Moreover, they focus on land that has also been lost or degraded due to changes in land use, preventing illegal logging, the advance of the agricultural and livestock frontier, and the expansion of urban areas (CONAFOR, 2020a).

Considering the above, CONAFOR guides strategies to address forest areas through reforestation activities, in conjunction with soil conservation and restoration works, as well as protection and maintenance of restored areas (CONAFOR, 2020a). Between 2011 and 2020, CONAFOR implemented public policies split into three different administrations one from December 2006 to November 2012, the second from December 2012 to November 2018, and the third one from December 2018 to September 2024. Each administration has developed the main program through which support was channeled for different activities promoted in the silviculture sector.

PROÁRBOL Program

This program was created in 2007 to reduce poverty and marginalization rates in forest areas by inducing proper management and use of natural resources. They generate development and economic expansion from the valuation, conservation, and sustainable use of the resources of forests, jungles, and vegetation of arid zones. Additionally, they promote forest planning and organization to increase the yield and productivity of forest resources. The program's incentives were assigned through two statutes: the Operating Rules and the Guidelines, where support concepts such as silviculture, certification, commercial forest plantations, reforestation, soil conservation, forest health, and payment for environmental services are considered, through which community members and landowners have benefited from (Gutierrez, 2012). The program was in effect until 2012.

PRONAFOR

It is a response to address the environmental, social, and economic problems faced by the silviculture sector, based on the diagnosis during the formulation of the National Development

Plan 2013-2018. PRONAFOR was a public policy of national coverage, which contributed to promoting and guiding inclusive and facilitating green growth. This policy helped preserve natural heritage while generating enabling conditions for the conservation, protection, restoration, and sustainable use of natural resources, as well as participating in the formulation of plans, programs, and applying a sustainable silviculture development policy (CONAFOR, 2018).

Support Program for Sustainable Forestry Development (ADFS)

It was developed in 2018; designed to support the owners, legitimate possessors, and inhabitants of forest areas to implement actions that contribute to the protection, conservation, restoration, and incorporation into sustainable forest management of forest land, preferably forest and temporary silviculture. It also supported strengthening value chains, contributing to the adaptation and mitigation of Climate Change effects (*Diario Oficial de la Federación*, 2022).

Among the programs that have lasted the longest throughout the decade is the Environmental Compensation for Land Use Change in Forest Lands (CUSTF), which was later called Environmental Compensation, and was implemented for eight years from 2012 to 2018. It is important to highlight that REDD+ Early Action Areas Special Program was implemented in 2014 and 2015. The main programs of each administration maintained the conservation and restoration components and the environmental services component. However, in 2020 the latter focused on strategic micro-Basins belonging to indigenous peoples. Likewise, the environmental services component remained during those ten years.

It is worth noting a trend from 2013 to 2019, where CONAFOR channeled a large part of the components of its programs to forest productivity.

CONAFOR has maintained within its public policies programs directly related to restoration throughout the decade from 2011 to 2020, such as the CUTF program and the conservation and restoration components, as well as the environmental services component that it develops in some way restoration actions have been maintained. It is worth noting an increase tendency in the number of special programs for certain regions[1] of the country from 2012 to 2013. Programs with restoration actions must be considered, such as forest plantations, which were presented as a component in 5 years during the decade. The description of the leading programs and their details can be seen in Annex III.

CONANP

The National Commission of Natural Protected Areas (CONANP) was created in 2000 as a decentralized body of SEMARNAT. CONANP has implemented the Conservation Program for Sustainable Development (PROCODES) which emerged in 2007 and replaces the Program for Sustainable Regional Development (PRODERS). In addition, in 2019, the Program for the Protection and Restoration of Ecosystems and Species at Risk (PROREST) was created.

PROCODES

CONANP within PROCODES supports restoration and Rehabilitation activities, defined as actions by community brigades that favor the recovery and reestablishment of conditions conducive to the continuity of natural processes in ecosystems that have been affected by some forest fire in the Priority Region.

The operating rules of PROCODES in 2020, include ecosystem restoration projects for productive purposes (CONANP, 2020).

PROREST

The Program for the Protection and Restoration of Ecosystems and Priority Species Program promotes the conservation and restoration of representative ecosystems and the biodiversity of natural protected areas. As part of the restoration practices consider the following activities (CONANP, 2020).

SADER

One of the non-environmental institutions in Mexico that have developed restoration actions has been the Ministry of Agriculture and Rural Development (SADER), which from 2000 to 2018 was the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), and currently Sec-

1 Pátzcuaro and Zirahuén Special Program, Cutzamala Special Program, Purépecha Plateau Federal Silviculture Program, Sustainable Development Project for Rural and Indigenous Communities of the Semiarid Northwest (PRODESNOS), Community Forestry Development Project for the Southern States (DECOFOS), Basins Special Program Coastal Areas in the State of Jalisco, Special Program for the Conservation, Restoration and Sustainable Use of the Lacandona Forest, Special Program for the Restoration, Conservation and Community Forest Development Chimalapas , Special Program for the Conservation, Restoration and Sustainable Management of Forest Resources of the Yucatan Peninsula (PEPY), Program for the Ecological Restoration of the Flora and Fauna Protection Area "Bosque la Primavera", Program for the Restoration, Protection and Development of the Tarahumara zone in the State of Chihuahua, Program for the Restoration of the Río Verde Grande Basin in the State of Aguascalientes, Program for the Restoration of the Upper Part of the Nazas River Basin in the State of Durango, Special Program for the Conservation, Restoration and Sustainable Use of the Lacandona Jungle.

retary of Agriculture. This secretariat has maintained the Conservation and Sustainable Use of Soil and Water component (COUSSA) from 2011 to 2020.

Coussa component

CONAZA operates COUSSA, which emerged in 1970 as a decentralized agency of the Federal Government with its own assets and resources, to serve a significant group of the population that lives in the arid and semi-arid areas of the country *(Cuenta Pública Hacienda Gobierno de México*, 2018).

The COUSSA Component aims to "contribute to solving the problem of soil degradation, over-exploitation of vegetation and lack of water availability; for agricultural activities". It is aligned with the priorities of the sector policy and with the National Development Plan 2007-2012 in its specific objective of reversing the deterioration of ecosystems through actions to preserve water, soil and biodiversity. By guiding its actions through support concepts relevant to achieving its goals, the Component is oriented toward addressing a well-identified problem. However, targeting its investments requires greater precision to address more compact focus areas (SAGARPA, 2013a).

The strategic lines of the Component seek to guide actions to increase the availability of rainwater in productive activities. To improve the vegetation cover of rangelands and promote the infiltration of rainwater into aquifers through the construction of small works for collection and water storage, as well as carrying out soil conservation works and practices.

For its execution, the COUSSA Component considers four operation modes, two of which are direct performance, where the executing agency is the National Commission for Arid Zones (CONAZA). The first is the Strategic Project for the Development of Arid Zones (PRODEZA), and the second is Small Hydraulic Works (POH).

The other two execution modalities are operated through the state governments, where the Secretaries of Agricultural Development (or equivalent) are the executing instances, one associated with the Strategic Food Security Project (PESA) and the other in concurrence with Federal-state resources, which is the modality on which this evaluation focuses (SAGARPA, 2013b).

Secretariat of Welfare

The Welfare secretariat was created in the administration from 2018 to 2024, under the federal government. Part of its mission is to improve the levels of well-being, inclusion, and equity through the consolidation of comprehensive public policies with sustainable development and political inclusion. Within its programs is the *Sembrando Vida* program, which, according to the secretariat, seeks to address two problems, poverty and environmental degradation (Government of Mexico-Welfare secretariat, 2022).

Sembrando Vida Program

This program will encourage agricultural subjects to establish agroforestry production systems, which combine the production of traditional crops with fruit and timber trees, and the method of Milpa Intercalated between Fruit Trees (MIAF). This will generate jobs, encourage food self-sufficiency, improve the inhabitants' income, and recover the forest cover of one million seventy-five thousand hectares in the country (*Diario Oficial de la Federación*, 2020). Caring for the environment is one of the four components managed by the program

Other institutions belonging to the federal government that carry out restoration actions

There are other institutions belonging to the Mexican government that develop restoration actions through different projects implemented by other actors such as CSOs, see Chart 1.

Eligibility areas

The different institutions of the Mexican government define their areas of eligibility based on their mandate. For example, CONANP implements restoration actions with its programs only in PA and its area of influence. The case of CONAZA is similar, focusing on the country's arid zones. In both instances, committees are formed that evaluate the support proposals and allocate resources based on the available budgets.

Therefore, it is up to CONAFOR, through studies and investigations, to define the eligible areas in regions or forest ecosystems of the national territory. These areas are bounded through polygons on a map, linked to latitude and longitude coordinates, and program-specific information (SEMARNAT-CONAFOR, 2020). Next, the "Eligible Areas Protocol, 2020," prepared by the Reforestation and Restoration of Hydrographic Basins Management of CONAFOR (Table 2).

The process for the definition and updating of priority areas is shown in Chart 2. The said process generates eligibility maps (CONAFOR, 2020).

Chart 1 Other federal government institutions that carry out restoration actions

CONABIO

It is an inter-secretarial permanent commission created in 1992 permanently (Government of Mexico, 2021). It has the Environmental Restoration and Compensation Program. Their main objectives are to execute actions to restore or recover our country's ecosystems and natural resources, which were damaged or deteriorated for various reasons. It also supports the development of activities aimed at direct conservation through managing and protecting ecosystems and their biodiversity, including their sustainable use (CONABIO, 2021).

Within its thematic lines it has restoration, which are activities aimed at favoring the recovery and restitution of ecosystems, habitats or species that have been directly or indirectly degraded, damaged or destroyed.

A1. Restoration, recovery, reforestation or remediation actions in damaged areas.
A2. Reintroduction of disappeared species or extirpation of invasive species.
A3. Studies that support restoration actions (biological inventories, ecological, socioeconomic studies, etc.).
A4. Monitoring of restoration actions in the short and long term.

INECC

It was created in 2012 to provide the technical and scientific support that SEMARNAT required to formulate, conduct, and evaluate the national policy on topics such as climate change, environmental protection, and preservation and restoration of the ecological balance (Cuenta Pública Hacienda Gobierno de México, 2014).

The INECC does not apply public policy instruments directly like other institutions but collaborates on different projects on restoration.

- The project "Connecting the health of the Basins with sustainable livestock and agroforestry production (CONECTA)" with the Mexican Fund for the Conservation of Nature (FMCN) this project has four components (Government of Mexico, 2022). Where its third component focuses on the conservation, restoration, and implementation of climate-smart practices in livestock and agroforestry landscapes.

- Project "RÍOS" aims to increase the adaptive capacity of people and ecosystems in basins vulnerable to climate change by restoring rivers. Its duration is five years of the project (2021-2026). It is in charge of the Mexican Fund for the Conservation of Nature, A.C., with the technical leadership of the National Institute of Ecology and Climate Change (Government of Mexico, 2022). In its third component, the project focuses on designing the National River Restoration Strategy (ENRR).

  It is relevant to mention that INECC, its attributions, and its staff became part of SEMARNAT, by the end of 2021.

Chart 2 Eligible Areas Protocol of CONAFOR 2020

• Socioeconomic Considerations

Within these considerations, the aim is to define priority areas with a target population and are based on the following criteria:

- Presence of indigenous peoples
  - Number of inhabitants (Women / Men)
  - Level of marginalization
    - Very high and high
- Degree of vulnerability
    - Very high and high
- Availability of time to actively participate in the project
- Interest in establishing productive activities in the area
- Approximate total monthly income
- Approximate monthly income from silviculture activities
- The maximum educational level of potential beneficiaries

The analysis of previously listed parameters provides the target population.

• Resource efficiency

Resource efficiency considers the proper use of resources and efforts in its application and ensures that the benefit reaches those in most need.

• Social

It is sought that the program has high acceptability and is integrated into the communities' social, economic, and cultural environment. It must respect the communities' self-management over their territories and biocultural heritage.

It is important to consider the interaction of forests and jungles with communities and peoples as well as social, cultural, and economic elements.

• Ecological considerations

• Intervention areas

The forest restoration actions granted through support from CONAFOR are oriented to areas determined as priorities. The selection process requires expedited steps that are strengthened and generate new cross-cutting activities, culminating in a forest management plan—the restoration of the natural heritage and social welfare.

Selection criteria are established to delimit the highest priority areas; wherever interventions converge in the territory. These criteria must meet the parameters of the object to be intervened, i.e., degraded forest ecosystems. In addition, and without diminishing importance, since the owners or possessors of the forest territories are directly responsible for the use of the land. Priority is given to those that present more vulnerable conditions and, therefore, less solvency to attend to problems that they consider essential, although in second place, given the economic conditions prevailing in the region.

Identifying surfaces that comply with environmental, economic, and social aspects may receive support considering that the beneficiaries lack resources to carry out restoration projects, starting with actions to recover forest territories that once had forest vegetation, generating ecosystem benefits to the participating and surrounding communities.

• Management of the forest territory

The altered forest territories can be restored or rehabilitated with protection measures (against fire, grazing, and erosion) or by accelerating the processes for their natural recovery (direct seeding or planting of a diversity of species, both in primary or secondary forests with processes of degradation), linked with soil conservation works.

The MIT approach is aimed at managing the dynamic and often complex interactions between people, communities, natural resources, and land-use types that are integrated into the territory.

• Additional considerations

Mexico's international commitments in terms of restoration are considered:

- The United Nations Decade Initiative for Ecosystem Restoration.
- The Sustainable Development Goals of the 2030 Agenda.
- The Bonn Challenge and the 20x20 Initiative.

• Methodological process

A methodological process was implemented to determine the priority areas where restoration activities are planned to be carried out.

1. The micro-basin must be considered as basic planning unit.
2. Characterization of the micro-basin - spatial analysis of factors and variables of interest, within which climatic, edaphic, soil condition and natural resources (degradation, erosion) criteria stand out, in addition to the economic, social and cultural type.
3. All the factors are related.

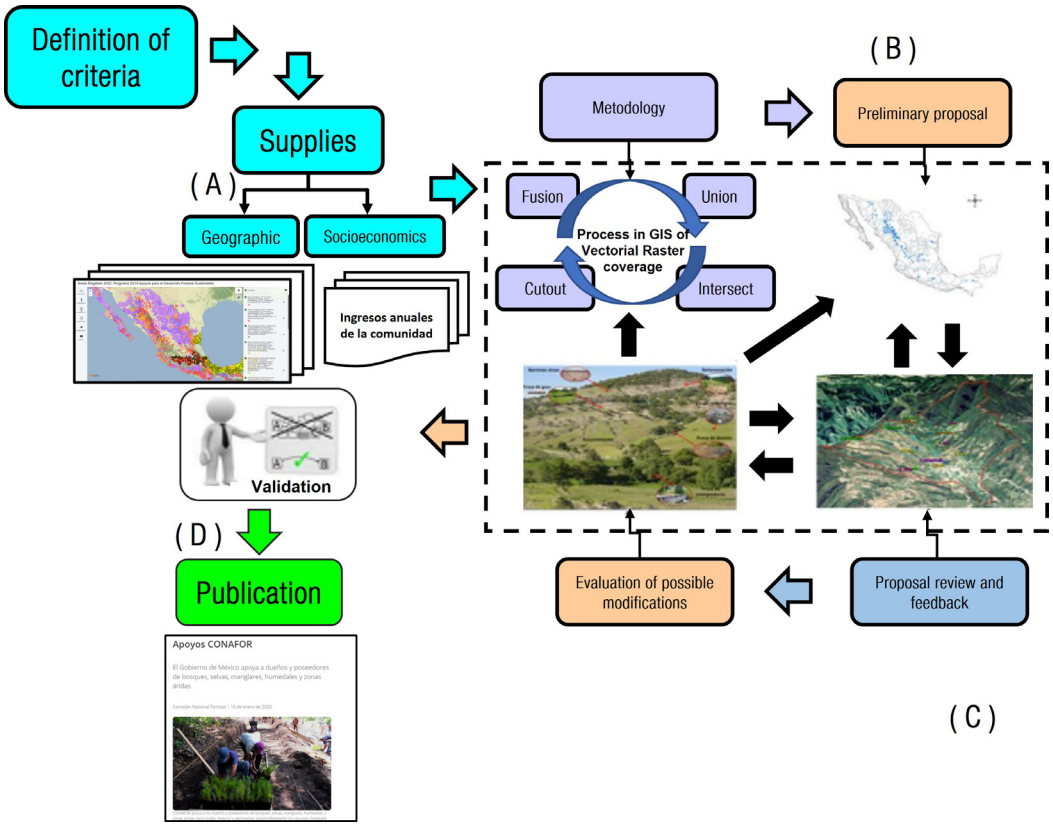

Figure 2 Diagram of the process for the definition and update of Priority areas.

Source: taken from the "Protocol of Eligible Areas 2020" published by CONAFOR.

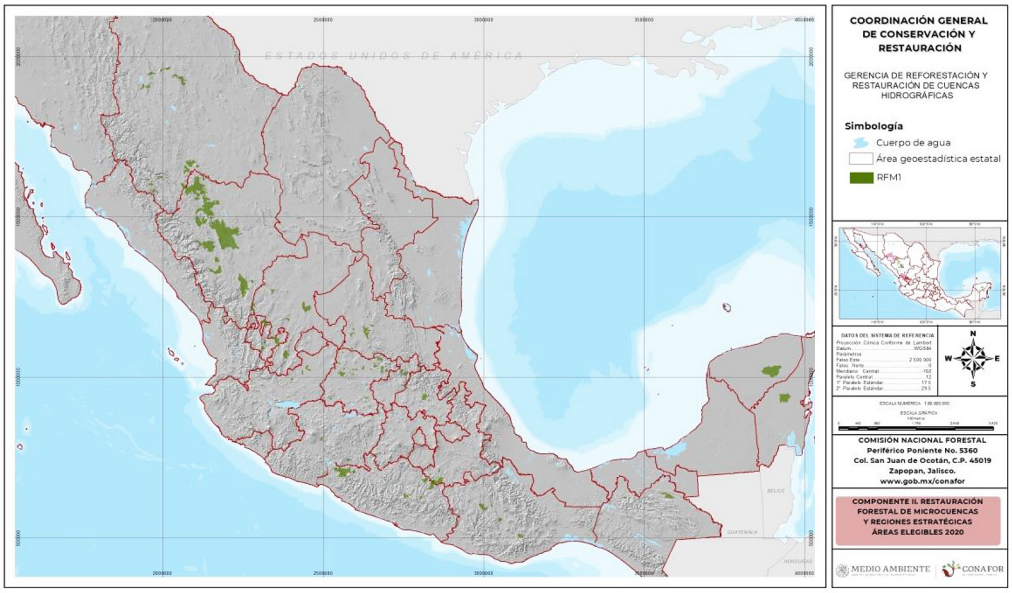

Figure 3 Map of eligible areas 2019. Forest restoration and productive reconversion.

Source: taken from the "Protocol of Eligible Areas 2020" published by CONAFOR.

4 Monitoring of restoration in Mexico

Monitoring platforms

In Mexico, the information related to restoration processes is dispersed in different databases of equally diverse institutions. Although it can be used to generate monitoring processes, no available references are exclusively oriented to do so. Therefore, to apply the Restoration Barometer, it is necessary to process the accessible data concerning certain analytical variables (e.g., type of restoration activity [2].

Platforms (reservoirs of information) related to restoration processes have been identified (see Annex IV). Notice that none of these integrates the generation of analysis processes that lead to better decision-making at the local level. However, practically all of them have layers of information that are useful to demonstrate the relevance of implementing restorative actions based on, for example, priority conservation sites or areas of high forest productivity.

Although some of the systems have the possibility of interconnecting to other data sources, these are either outdated or not explicitly related to restoration.

There is no analysis of the permanence or effect of the restoration actions, and there are no specific thematic layers such as the restoration carried out by type of ecosystem. At a country level, there is no system of its own for the information generated, directly or indirectly, around monitoring restoration. However, a majority tend to visualize technical details.

In Mexico, it is necessary to systematically document the restoration actions to determine its current status and prospect future steps in the country since the efforts to recover the ecosystems' conditions, processes, and functions have mainly happened in a disjointed way (Mendez-Toribio et al., 2018a).

Since 2020, CONABIO has begun implementing a national-scale project to compile existing data on experiences of ecological restoration, production, remediation[3], re-introducing fauna, and natural regeneration, among others. For this, the National Information System for Environmental Restoration is being developed, which is expected to be ready in 2023 (CONABIO, 2020).

Apart from the initiative mentioned above, at a national level, at the time of writing this document, there are few structured efforts aimed at systematizing restoration actions, with efforts focused on specific regions or ecosystems (Calva-Soto & Pavón, 2018).

2 See the typology of restoration interventions for terrestrial ecosystems: https://restorationbarometer.org/wp-content/uploads/2022/02/iucn_restoration_intervention_typology.pdf

3 According to the LGEEPA, remediation is understood as the set of measures adopted at a given site to reduce or eliminate contaminants to a safe level for the environment and health (Official Gazette of the Federation, 1988).

5 Methodology for the analysis of restoration

Restoration analysis

Ecosystem restoration consists in preventing, halting and reversing the degradation of ecosystems worldwide to regain their ecological functionality and improve productivity and capacity to meet the needs of society (IUCN, 2022).

That is why restoring ecosystems today is interpreted as a fundamental action to transition to societies tending toward sustainability (IRP, 2019).

In Mexico, some territories have lost up to 80% of their original ecosystems (Dave et al., 2018), such as the Gulf states.

The evaluation of the country's natural capital reveals that two-thirds of its present high levels of degradation, and 65% of the municipalities present their natural capital in a non-sustainable condition (Mora F., 2018)

In 2013, the Government of Mexico committed to restoring 8.5 Mha of land by 2020. In the country, various public institutions, such as the National Forest Commission, carry out multiple programs and subsidies that pay part of the initial investment for a wide variety of activities with restoration potential. Available public registries make it possible to estimate the progress (Dave et al., 2018).

If the actions conducted by other sectors such as Non-Governmental Organizations or Private Initiatives are added to this, it becomes feasible to know the general state and the effects derived from the main restoration actions in the country.

To support national monitoring effort, the International Union for Conservation of Nature carried out the compilation and systematization of the existing data on the restored areas by government programs, civil society, private initiatives, and international cooperation, in Mexico from 2011-2020 at a national scale.

This information will not only represent a reference on the progress towards the goals established for 2020 but will also draw a baseline for Mexico in terms of Ecosystem Restoration for the analyzed decade.

Methodology

Recognizing the territorial reality at any scale allows optimal interventions to positively and effectively impact those elements requiring greater attention. For this, the situational diagnosis understood as a technical, planned, and systematic process of description and evaluative analysis of a specific situation in the organization of a territory, stands as a critical aspect for future interventions (Salazar Mora, 2020).

These processes, which can also be understood as inputs for territorial diagnoses, are "an essential element, not only in the formulation and articulation of public policies and their instruments but in general in defining mechanisms for their monitoring, evaluation and in decision-making processes" (Vega-Mora et al., 2002).

When applied to restoration processes, situational diagnoses give rise, among other aspects, to the generation of reflections linked to the status of the projects and the planning of actions to fulfill the commitments undertaken (Méndez-Toribio, 2018b).

As a starting point for its development, it is necessary to formulate guiding questions that serve as a guiding parameter to integrate the required base information for its subsequent description and interpretation (Bernal Granados, 2015).

In the case of the present work, 19 questions have been established to know key aspects of the restoration developed in Mexico during the decade from 2011 to 2020 (see Chart 3).

Based on the questions raised, information on official platforms at the country level was compiled, as well as academic sources that allowed the analysis to be generalized. However, either jointly or individually, specific methodological processes were carried out for the various questions, which are described below.

Restoration actions

Information on restoration actions developed by the government sector was systematized, particularly by CONAFOR, CONANP, and CONAZA, as well as by non-governmental organizations such as Ducks Unlimited Mexico and *Reforestamos Mexico*.

For this, databases were integrated using a unified Excel 2019 format derived from the standardized template by the International Union for Conservation of Nature to collect information related to the Restoration Barometer.

The Excel format was adapted to national conditions, so the modifications included the inclusion of federal entities and Municipality codes.

The codes that were applied were those assigned by the National Institute of Statistics and Geography (2018) to integrate a native identifier of each action represented. This was done through folios given to the different projects by their executing instances. A currency conversion factor (Mexican peso-US dollar) was added based on the annual averages of the daily exchange rate reported by the Banco de México[4] for the years analyzed and their equivalence to 2020; also, an automated conversion between the actions carried out and the types of intervention proposed in the Restoration Barometer (IUCN, 2022).

The restoration work carried out through the decade has been diverse, either due to the nature of actions undertaken or to discrepancies in categorization generated by the institutions

Chart 3 Guiding questions for the situational analysis of restoration in Mexico in the 2011-2020 decade

1. What were the different restoration actions developed in Mexico during the 2011-2020 period, and what surface did each impact?
2. What was the contribution of the government sector and non-governmental organizations regarding the total number of restoration actions carried out and intervened surfaces in the period 2011-2020?
3. What were the main restored ecosystems with the most significant influence concerning the restoration actions developed in Mexico during the 2011-2020 period?
4. How much economic resources were invested in restoration actions during the analysis period? and in what type of ecosystem has there been more investment?
5. What was the largest source of financing for the restoration actions carried out in Mexico during the 2011-2020 period?
6. What percentage of public spending related to environmental protection has been allocated to restoration actions in Mexico during the 2011-2020 period?
7. How many permanent or casual jobs have been generated throughout the analysis period from the restoration actions undertaken in Mexico concerning the total employment in the same years?
8. In the decade under analysis, what restoration actions have been developed in strategic sites to improve productivity?
9. Between 2011-2020, what restoration actions have been aimed at municipalities under conditions of poverty or high vulnerability due to climate change in Mexico?
10. What restoration actions have had a differentiated impact on indigenous and non-indigenous municipalities in Mexico between 2011 and 2020?
11. What was the incidence of restoration actions in Mexico in the period 2011-2020 in priority regions for conservation and restoration?
12. During the analysis period, what restoration actions were in priority areas for connectivity?
13. What percentage of the areas under restoration in Mexico during 2011-2020 have a formal designation as a protected area?
14. What percentage of areas under restoration in Mexico during the 2011-2020 period overlap with native/primary vegetation sites?
15. What percentages of restoration areas in Mexico during the 2011-2020 period affect critical sites for biodiversity conservation?
16. Which species in the risk category benefited from restoration actions in the decade?
17. How many intervened hectares contributed to the conservation of threatened species?
18. What was the quantity of CO_2 equivalent captured due to the restoration actions undertaken in Mexico during the analysis period?
19. How many hectares under restoration in Mexico during 2011-2020 have affected municipalities vulnerable to climate change?

4 SIE - Foreign Exchange Market (banxico.org.mx)

that developed them. Therefore, the IUCN Restoration Intervention Typology for Terrestrial Ecosystems (RITTE)[5] was used to build correspondence matrices allowing homogeneous categories. Table 3 shows an example of the restoration action equivalencies.

All the data reported in the web portals of each institution, or its absence was introduced into the final format. This data came from the databases of each institution, later generating descriptive statistics and cartographic products.

Financing

Comparative relationships were established between the metadata associated with the restoration projects to determine investment amounts and the percentage that these represent concerning the public expenditure carried out to protect the environment. These projects are found in the public databases and the databases of the National System of Environmental Indicators of the Ministry of the Environment and Natural Resources (SEMARNAT). Particularly those related to the National Accounts System of Mexico in its Economic and Ecological Accounts section, developed by the National Institute of Statistics and Geography (INEGI)[6].

In this way, it was possible to establish a percentage equivalence between the resources channeled to restoration actions and the total public investment related to environmental protection.

The equivalent amounts to those in 2020 were determined using the consumer price index (CPI) generated by INEGI to obtain the equivalences around the value of investments made in the country's restoration during the analysis.

The CPI measures the evolution of consumer prices for goods and services over time. According to the World Bank (2022), this is usually used to update the monetary values of economic flows concerning purchasing power between a given previous period and the current moment.

It is possible to determine the current value of the Mexican peso for a given year based on the following Formula 1, if a reference to the CPI for both times applies (Argüello H, 2019):

$$Value\ of\ the\ current\ year = Value\ of\ the\ beginning\ year * \frac{CPI\ of\ the\ current\ year}{CPI\ of\ the\ beginning\ year}$$

Application example:

$$Value\ 2020 = Value\ 2019 * \frac{CPI\ 2020}{CPI\ 2019} = 1 * \frac{122.56}{118.53} = 1.03$$

Formula 1 Calculation of the present value of a given economic flow in previous years.

Following the recommendations of the International Labor Organization, to ensure its relevance, it is necessary to update the CPI every five years or even more frequently in landscapes experiencing significant economic changes (ILO, 2006).

However, in Mexico, the period of reference remained unchanged for eight years of the decade of study (2010-2018), according to INEGI (2018). The present analysis considered

Table 3 Example of equivalence between restoration actions and IUCN typology

Actions declared by the institution that developed the activity	Equivalence based on the IUCN intervention typology	
CONAFOR - PRONAFOR	**First level**	**Second level**
A2.1 Forest cultivation in timber exploitation.	Silviculture	-
A2.5 Forest roads	Silviculture	Maintenance or closure and dismantling of roads
EP1.3 Establishment and management of areas of high value for conservation	Soil/water protection / conservation actions	Protection of places/areas/habitats, for example, establishment of community conserved areas/protected areas
Mexican Fund for Nature Conservation	First level	Second level
9. Number of hectares that are under sustainable use.	Silviculture	-
10. Number of hectares restored or in the process of restoration.	Assisted natural regeneration	-
11. Number of protected hectares or biological corridors.	Soil/water protection / conservation actions	Protection of places/areas/habitats, for example, establishment of community conserved areas/protected areas

Source: Own elaboration.

5 https://restorationbarometer.org/knowledge-hub/iucn-restoration-intervention-typology-for-terrestrial-ecosystems/

6 https://www.inegi.org.mx/programas/ee/2013/default.html#Tabulados

the most current available data in the country for applying Formula 1. The amounts were converted to dollars using a currency conversion factor calculated for 2020, based on the annual average rate of daily change reported by the *Banco de Mexico*[7] during that year.

Economy

On the other hand, the number of jobs derived from the restoration actions was determined using the metadata of daily wages associated with the restoration projects. The metadata was found in the public databases to which access was granted. Whenever the data was not reported, references were used instead. The "Agreement by which the reference costs for reforestation or restoration and its maintenance are issued for environmental compensation for change in land use on forest land and the methodology for its estimate", states each reforestation or restoration action stipulated by the National Forest Commission. This agreement was published in the *Diario Oficial de la Federació*n in 2006 and updated for 2014, as well as the "Reference terms of the sustainable silviculture development support program 2018".

Greater detail on the methodology used by the institution to estimate wages by activity and area is described in Annex V.

A standard conversion factor related to the restored surfaces was used for the actions where wages were not reported and that are not considered in the official national references.

This factor was determined through a bibliographic approach in which works published during the project analysis period (2011-2020) were privileged, as well as systematic literature reviews.

Six studies applicable to various countries in the Americas were identified, with specific references regarding the number of jobs generated by restoration activities based on the amounts invested or the hectares intervened. Although there are different values for the various actions, it is noteworthy that three of these coincide with the magnitude of 0.2 jobs generated per hectare. Therefore, to present greater consistency and given the limitations of the existing databases, this was the conversion factor selected in cases with no official references.

An equivalence table was built considering the intervention levels of the RITTE. It includes the number of wages per hectare associated with them, either in the reported metadata, national references, or the derivatives of the standardized conversion factor for activities not considered (see results section: Restoration actions developed in Mexico during 2011-2022).

Notice that according to the evaluations applied to public restoration policies in Mexico, developed by CONABIO (Cervantes V, 2008), forest and soil improvement programs have typically generated casual, or intermittent jobs; this is reinforced by works such as those carried out by BenDor et al. (BenDor, 2004). They mention that most jobs derived from restoration actions are partial or temporary in North America.

The calculated wages were associated with this category of jobs. Thus, all were divided by 132, which according to CONEVAL (CONEVAL, 2019), is the maximum number of days that a casual job in the environmental sector, among others, in Mexico.

The number of jobs generated was contrasted with the Green Jobs reported by the INECC's Directorate for the Economy of Natural Resources (SEMARNAT, 2015) to estimate how many of these come from restoration actions.

According to the Economy Department of the INECC - SEMARNAT (2015), for a job to be considered green, it must be done by a person whose economic activity is to exploit, protect and benefit the environment sustainably. It must also include actions of production, prevention, or reduction of environmental damage. An increase in the value of this indicator shows the increase in the labor force related to the activities mentioned, which may translate into a stimulus to production, consumption, or environmental benefits, among other aspects.

That is why the determination of green jobs in the country is made by adding the number of jobs categorized as such in the following sectors of the economy: Agriculture, Silviculture, Water, Transportation, Manufacturing, Fishing, Waste, Electric Power, Tourism, Mining and Oil and Gas Extraction, Government, Educational Services, Professional Services, and Construction. The reports on the number of dependent persons linked to a company name for each class of economic activity are taken as a basis (SEMARNAT 2016).

Annex V shows a broader description of the procedure used and the limitations of this parameter.

The total amount of jobs was contrasted with green jobs in the country. The estimated number of jobs associated with the restoration was subtracted, and the percentage that this represents was calculated.

Based on the data accessed, a case study from which referential information could be obtained to respond to it was used to approach topic 10 (see the complementary analysis section).

7 SIE - Mercado cambiario (banxico.org.mx)

Analysis space at the municipal level

A vector format file was generated to spatially represent the actions developed because the most advanced homologous level was the municipal level. The references collected for each territorial division of the country were integrated into the format. The geographical key of each municipality was used as a linking criterion, which allowed to set a correspondence with the subdivision of Mexico[8].

With the information generated at the municipal level, it was possible to establish overlaps between it and various official spatial information layers for the country on the same scale or built specifically for this report.

From the previous, concordance analyses are derived between the restoration actions and each reference presented in Table 4. The analyzes in question were prepared in ArcGIS Pro version 2.8, integrating the values of the overlapping geographic objects, allowing it to give rise to integrated databases.

To obtain detail of each layer, the elaboration methodology in the case of those developed by the authors, and the path to the source, review Annex V.

The potential impact of restoration actions on the productive component, specifically in the silviculture field, was also determined through an indirect approach.

For this, an overlapping of information layers and integration of databases was carried out to focus on the restoration projects that were accessed based on the forest zoning of the country developed by CONAFOR, particularly in the category II corresponding to the concept of Production.

According to CONAFOR (2021), this category spatially incorporates the areas that have adequate vegetation and soil conditions for the sustained production of timber and non-timber products, using data from the INFyS and classifying them as:

- High-productivity forest land: Includes those with a canopy cover of more than 50% and an average height of trees equal to or greater than 16 meters.
- Forest lands of medium productivity: These present canopy cover from 20% to 50% and average heights of less than 16 meters.
- Low-productivity forest lands: Represented by sites where the canopy cover is less than 20%.

The percentage of the total area of each municipality that coincides with the various categories of productivity (high, medium, low) was calculated because the forest zoning of Mexico is calculated on a national scale, and the restoration projects of the decade under analysis were integrated at the municipal level. The specific procedure is described in the corresponding section of Annex V.

Once the previous procedure was done, it was possible to contrast the two references in question. Thus determine, through dynamic matrices, the number of actions, surfaces, and amounts (obtained from the restoration projects layer metadata) executed during the study period in the municipalities with greater or lesser surfaces according to their range of productivity for silviculture use.

As a complement to the job creation indicator contemplated by the Restoration Barometer, the correlation of amounts allocated to restoration actions was determined regarding municipalities

Table 4 Layers of geographic information to carry out municipal analysis. Source: Own elaboration

Analysis Dimension	Referrer	Source
Environmental dimension	Area designated for conservation by municipality	Own elaboration based on official data
	Priority area for restoration by municipality	Own elaboration based on official data
	Municipal ecological connectivity	Own elaboration based on official data
	Protected area in different categories by municipality	Own elaboration based on official data
Social dimension	Indigenous presence by municipality in the country	CONAPO
	Municipalities vulnerable to climate change	CONEVAL
	Multidimensional poverty by municipality	CONEVAL
Productive	Percentage of the municipal area with forest zoning categorized around timber and non-timber production	Own elaboration based on official data

Source: Own elaboration.

8 http://www.conabio.gob.mx/informacion/metadata/gis/muni_2018gw.xml?_httpcache%20=%20yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent%20=%20no

with high and very high poverty, also regarding municipalities with a more significant indigenous presence. Since this activity can improve the welfare of society not only from an environmental point of view but also by becoming a productive activity (Torres, 2020), promoting economic recovery and generating local livelihoods (FAO, 2021). The preceding is particularly important if one considers that by 2020, 11 million Mexicans living in poverty were located in forest areas, of which a high percentage belong to indigenous communities (SEMARNAT, 2020).

It was also analyzed whether a greater or lesser number of restorative actions were carried out in municipalities with areas identified as conservation or restoration priority. With this in mind, the metadata of the information bases and the layers of information generated by CONABIO (2016) and CONANP (2021) related to these conditions.

The preceding was done to determine if there was a behavior directly or inversely related to the set of variables Number of Restorative Actions by Municipality - Municipal Area Destined for Conservation, as well as with the binomial Number of Restorative Actions by Municipality - Priority Municipal Area for the Restoration.

Restoration actions are expected to be concentrated in the municipalities that present the highest proportions of the area under the category of medium, high or extreme priority for restoration and in the municipalities that show the least protected areas.

Biodiversity

Likewise, the incidence of restoration actions on municipal ecological connectivity was determined. For this purpose, a municipal connectivity trend was constructed based on the change in the spatial connectivity index of Vogelmann (1995) reported by multiple authors. For example, Echeverry and Rodríguez, 2006; Galván-Guevara et al, 2015, Farfán and Rodríguez 2016; Alarcón, 2017; Cruz and Gorozpe, 2019), present it for similar purposes. It is widely used in the international bibliography for determining the state of continuity of silviculture masses.

This is based on the area/surface ratio to evaluate the continuity of the original vegetation present in an area by applying the following formula.

$$CIj = Ln\left(\sum Ai_j \,/\, \sum Pi_j\right.$$

Formula 2 Connectivity Index.

Source: Vogelmann 1995.

For the present work, to determine the area (A) of fragments of original vegetation and its perimeter (P), all the categories of native vegetation reported by INEGI concerning Land Use and Vegetation of the country were considered, and not only the forest, as was detailed by the cited author. The previous is possible as long as there are municipalities in Mexico where the Pastizal or Xerophytic Scrub are the original vegetation. Higher CI values represent less fragmentation, therefore greater connectivity.

In order to build a rate of change in the connectivity of each municipality, it was necessary, through the use of GIS, to determine the total vegetation present, categorized as original, in each territorial subdivision and then calculate its area and perimeter to apply formula 2, this for both the series V of Land Use and Vegetation of Mexico, as well as for Series VII, which are positioned at opposite ends of the decade of analysis (For more details see the corresponding section of Annex V).

Using dynamic Tables, it was possible to identify the municipalities in which, according to official data and in the periods in question, there was a gain or loss of connectivity. The results were later correlated to establish concordances between the change in the CI and the total area intervened through restorative actions for each municipality in the country. This helps capture a possible relationship around the direction of restoration actions towards territories where connectivity is winning or losing.

Information products (maps) and calculation Tables were generated with all the references already described and based on the spatial processing carried out; to proceed with their description and analysis. The analysis focused on spatially explicit components was also carried out here. Still, in this case, municipal limits were not used since aspects such as species distribution areas and critical areas for conservation, among others, do not respond to them.

For this, the actions identified in the decade, for which it was possible to obtain associated polygons, are considered; selecting only those that presented a difference of +-5% of the declared area of intervention and the size of the site in the related geoform, which were called work polygons. Therefore, it is crucial to remember that this analysis is based on only a fraction of the total actions for restoration. The procedure applied for the treatment of data related to the section was the superposition of information layers referenced in table 5.

A vector file in *shape* format was integrated that included all the work polygons. This was used as a mold to cut the areas and calculate percentages of incidence concerning the referents of Table 5. Exclusively for question A, the records that, without having a polygon, were related to the PA in their metadata were considered too. The processes carried out are described in detail In Annex V.

Table 5 Layers of geographic information to perform spatial concordance analysis

Referrer	Source
Land uses and vegetation series 7	INEGI
Key Biodiversity Areas	BirdLife International (2022)
Key Species Records	CONABIO
State, Municipal, Ejidal, Community and Private Natural Protected Areas	CONANP

Source: Own elaboration.

Regarding the key species, only organisms with conservation priority in the country were taken into account. Those species that have a Conservation Action Program (PACE) were considered as such. This resulted in the identification of 54 taxa, of which CONABIO obtained historical records of presence from the National System of Biological Information[9].

Since the information related to the species reports is presented employing points, and what is intended to be analyzed is the direct or indirect effect, a methodology was designed to determine if the restorative actions have impacted sites of presence and their mobility areas. This was based on the minimum displacement distances proposed by Foppen (Foppen R.P.B., 2000) for mammals and small birds, as well as on the magnitudes of resistance to species displacement by vegetation designed by Gurrutxaga (2003).

A standardized displacement area of 3 kilometers was considered for all taxa. It is understood that there are evaluated organisms that may have essential differences in their mobility but that, being all vertebrates, have minimal dispersions of precisely that magnitude in common, which results in a homologation factor for the analysis (Gurrutxaga and Lozano 2009). From this surface, permeability buffers were built for each record. It was done considering for the study only those in which the vegetation present in the established area had percentages of resistance to displacement of less than 50%; that is, those sites where there is a reported organism, but its mobility is also viable. With this, it was possible to identify how many interventions directly overlap with areas where a specific taxon has been reported and how many more indirectly influenced it by being within its permeability areas. Greater detail of the process can be found in Annex V.

Climate

Two referents provided the estimates of CO_2 equivalent captured in the sites where the restoration actions took place. The United Nations Convention published the first referent to Combat Desertification. It indicates that it is possible to carry out carbon change analyses having the baseline of Soil Organic Carbon stocks (SOC) and some way of relating to the changes in land use/cover conditions (UNCCD, 2018).

As UNCCD (2018) comments, "land use/cover information is the dynamic component that informs SOC trends as a proxy for land use change."

The baseline recommended by the UNCCD for national assessments is the ISRIC SoilGrids250m information for a depth of 0–30 cm found in the QGIS Plug-In Trends, developed by Lund University, INTERNATIONAL CONSERVATION, and the United States Space Agency to make global estimates.

Therefore, this Plug-in was used to build the initial reference for this study, obtaining a raster image of Soil Organic Carbon (SOC) for 2011. Later, using Arc GIS Pro version 2.8, band number 3 of the raster image was extracted to obtain the values of the SOC per pixel of 250m x 250m, in Mexico. Subsequently, a polygonal layer was generated to be used in cuts by type of vegetation in the country to generate national averages of SOC in each. A simplified version was used to facilitate the analysis process in which all the forest types were grouped into a single category. It was done likewise to grasslands and secondary tree vegetation, secondary shrubby vegetation, and herbaceous (to see the final categories refer to the results section).

With this input and to evaluate the change in the decade regarding the amount of SOC, a comparative analysis was done between the land uses associated with the work polygons in series V and series VII of INEGI. It estimated the SOC differential in each of these based on the areas of each type of vegetation present in them and the factor national average for previously built land uses. Due to the number of polygons under analysis, it was necessary to obtain an isolated layer from both series of land uses and vegetation relative to the different classifications. Once done, cutting tools were used in ArcGis Pro using the work polygons as a template.

Each layer obtained from the previous procedure was converted into an Excel database which was later integrated into a single matrix to generate the study data. A correction factor of 0.32 was applied to all the SOC data relative to records with predominantly arboreal vegetation types and land use (Forest, Jungle, Mangrove, Secondary Arboreal Vegetation) that lost surface

9 Available at the following link: https://enciclovida.mx/

throughout the time of the study. Said factor was according to the methodological references indicated for those conditions. Such conditions are areas where wooded surfaces or forests are degraded to ecosystems such as grasslands, artificial, and crops, among others, assuming that 68% of the original soil carbon reserves are lost; still, the rest remains (UNCCD, 2018). For the sites with an increase in tree cover, a direct calculation was used based on the area and the estimated national average factor. A multiplication constant of 3.67 was used to convert the SOC to CO_2 equivalent (Jumbo et al., 2018).

The second reference to determine CO_2e was calculating carbon stores in aerial biomass.

For this, the previously calculated differentials in land uses were used, and the Annual Increase Factors of Aerial Biomass in Tons per Hectare (FIABA) were indicated as per the refinement of the IPCC guidelines (2019) concerning national greenhouse gas inventories. Thus, a FIABA Table applicable to the different types of vegetation was constructed, and the corresponding carbon fractions were also identified. These parameters were applied to the work polygons based on the area of each classification present in them and the lifetime of the different projects. As in the previous case, the resulting value was multiplied by 3.67 to obtain its equivalence in CO_2e.

The results of each procedure were added to obtain an integrated measure of the referents used. In this way, a final CO_2 value was generated.

Finally, based on the municipal information obtained, it was possible to determine the number of hectares with restoration actions that affected municipalities vulnerable to climate change. This was a way of evaluating the to which extent restoration activities are responsive to national priorities for climate change adaptation.

6 Results

Restored area

It was possible to obtain information on restoration actions associated with spatially explicit data from two institutions, the National Forest Commission, specifically from three programs (Basins Restoration, Compensation for Land Use Change and Reforestation), and Reforestamos México. Also, data was obtained, although without being linked to polygons, from the rest of the programs developed in the decade by CONAFOR, the PROREST and PROCODES programs of CONANP, CONAZA, as well as from the *Sembrando Vida* program, and DUMAC. With this data, the following results were constructed. Although the appearance of the SADER in 2018 promptly increased the number of actions related to restoration in that year, in all cases, there is a downward trend, which is most identifiable in those organizations that have historically dealt with the issue, as is CONAFOR. Figure 4 shows the number of projects associated with restoration actions per year per institution. In total, 493,826 restoration interventions/projects have been carried out on 5,219,986 hectares.

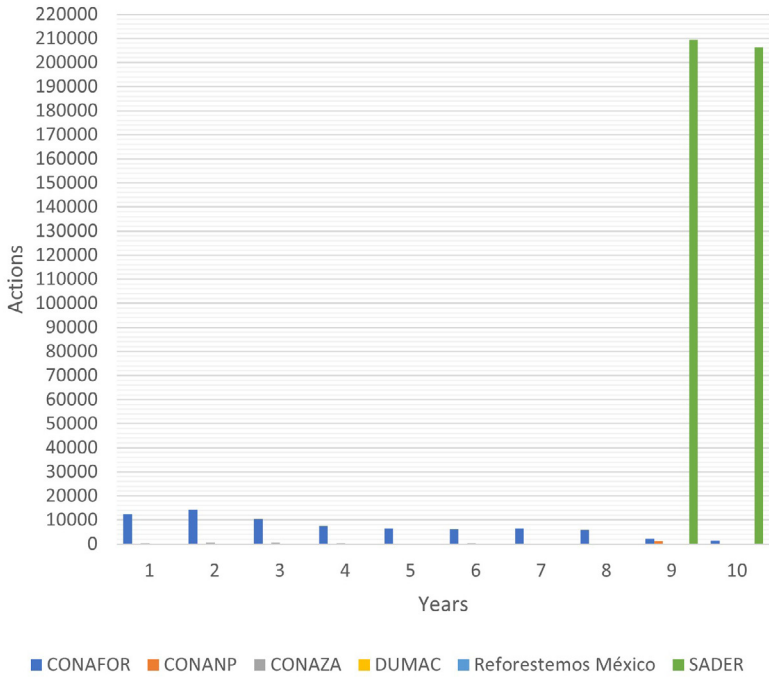

Figure 4 Number of restoration interventions per institution analyzed per year.

Source: Own elaboration.

Restoration actions developed in Mexico during the 2011–2020 period

Based on the information accessed during the study period, 493,826 restoration actions were carried out in 2,088 municipalities in Mexico, equivalent to 85% of the country's municipalities. Of a total of 27 activity type, 85% correspond to agroforestry modules, while 5.88% to reforestation; the rest are distributed in percentages lower than that. Table 6 shows the types of restoration actions developed in the decade, their equivalence with Restoration Intervention Typology, and the number of projects associated with each one.

As it is possible to see in Figure 5, most intervened municipalities have restored surfaces of less than 14,000 ha. There are some more, especially in the peninsulas and central-north of the country, where it is possible to identify the greatest concentration of area with restoration actions.

Contribution by the public sector and civil society regarding the restoration actions carried out, and surfaces intervened in the period 2011-2020.

Only the projects of Reforestemos México and DUMAC provided restoration information; therefore, the representativeness of the civil sector is not significant in the study, but it is not representative of the sector either. For it is known that there are other initiatives of which, to date, data could not be obtained.

Consequently, rather than distributing the results between the civil and public sectors, this document presents a breakdown by type of institution involved in this analysis.

As mentioned, the total projects in the decade based on the data analyzed is 493,826, of which SADER has carried out 84% through the *Sembrando Vida* program, followed by CONAFOR with 15% (Table 7).

Table 6 Restoration and equivalence actions, developed in the decade

Restoration Actions	Equivalence Bonn Barometer	Number of Projects
Agroforestry Modules	Agroforestry / silvopastoral system	419,237
Reforestation	Artificial regeneration	29,059
Comprehensive restoration	Artificial regeneration	8,850
Restoration	Artificial regeneration	7,181
Maintenance of reforested or restored areas	Silviculture	6,250
Protection of reforested or restored areas	Silviculture	5,090
Soil Conservation and Restoration	Soil/water protection / conservation actions	4,262
Commercial forest plantations	Silviculture	3,406
Silviculture	Silviculture	2,868
Complementary restoration	Artificial regeneration	1,768
Forest cultivation in timber exploitation	Silviculture	1,720
Biodiversity Conservation	Plantation of forests and forest plots	1,208
Water harvesting works	Creation/enhancement of habitat for native wildlife species	750
Ecosystem Restoration	Soil/water protection / conservation actions	544
Fire management actions	Artificial regeneration	469
Phytosanitary management actions and control of undesirable vegetation	Silviculture	368
Forest restoration	Control of invasive/problematic species	337
Conservation and restoration	Soil/water protection / conservation actions	166
Habitat improvement (Waste management and removal)	Soil/water protection / conservation actions	121
Basins Restoration	Silviculture	50
Maintenance of agroforestry modules	Agroforestry / silvopastoral system	42
Opening and desilting of natural channels	Hydrology Restoration	35
Protection	Soil/water protection / conservation actions	14
Establishment of silvopastoral modules	Agroforestry / silvopastoral system	11
Management of Acahuales	Artificial regeneration	9
Rehabilitation of pastures	Soil/water protection / conservation actions	7
Plant acquisition and reforestation with native species	Plantation of forests and forest plots	4

Source: Own elaboration.

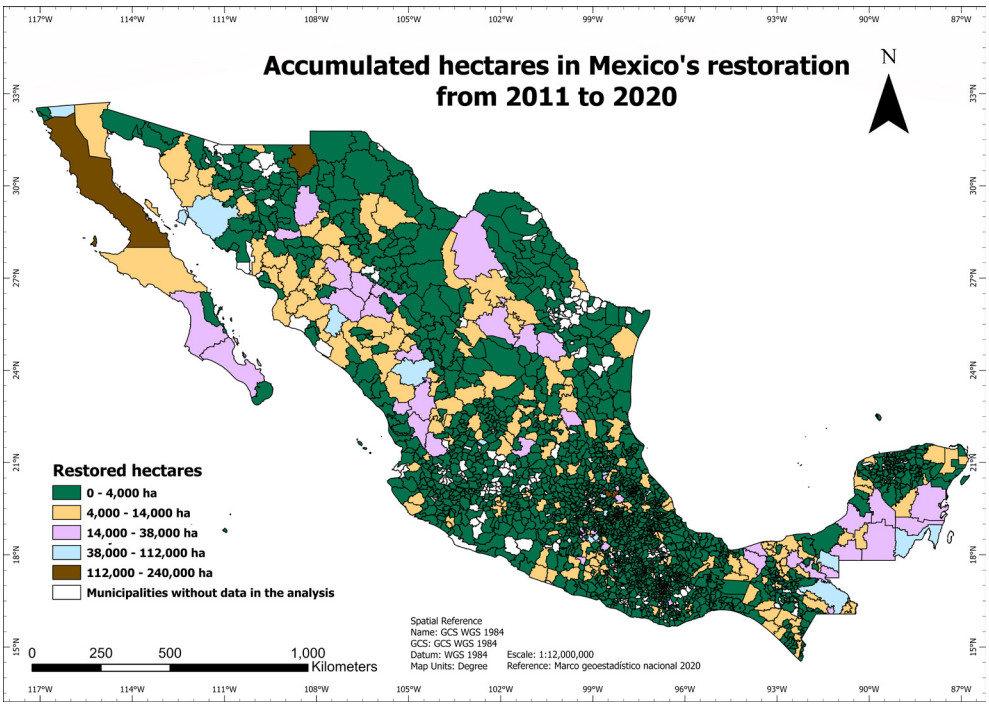

Figure 5 Hectares restored by municipality from 2011 to 2020.

Source: own elaboration.

Table 7 Number of projects developed in the decade by institution

Institution	Number of Projects	Percentage
SADER	415,692	84.18%
CONAFOR	73,295	14.84%
CONAZA	3,166	0.64%
CONANP	1,200	0.24%
Reforestemos Mexico	443	0.09%
DUMAC	30	0.01%

Source: Own elaboration.

In figure 6, it is possible to observe the different municipalities with restoration actions in the decade and the number of institutions that intervened in them.

In terms of intervened area, which has been 5,219,986 Ha in the decade, the highest proportion corresponds to CONAFOR with 72%, followed by SADER with 20% and CONAZA with 6%, see figure 7.

Main ecosystems restored in the period 2011–2020

Based on those restorative actions, it was possible to obtain intervention polygons using the Table of equivalences between land uses and vegetation in the country and the RITTE (see Annex VII). It can be indicated that the most extensive area restored occurred within the ecosystem classified as Forests and woodlands and the minor urban areas. (Table 8).

Notice, although 31,597 polygons were accessed (i.e., georeferenced restoration action), only 22,046 corresponded to work polygons because in these, as mentioned above, the variation in the declared area of intervention with restoration actions and the effective area of the geoform provided has a difference less than or equal to 5%. In the rest, the variation was more significant, in some cases exceeding 50%, which is why they were discarded. The total area associated with these is 806,126 ha. Based on the work sites, 2013 was identified as the year when most restoration projects took place in the decade, and 2014 was the cycle in which the most area was intervened. These parameters drastically decreased during the last two years analyzed (Figure 8).

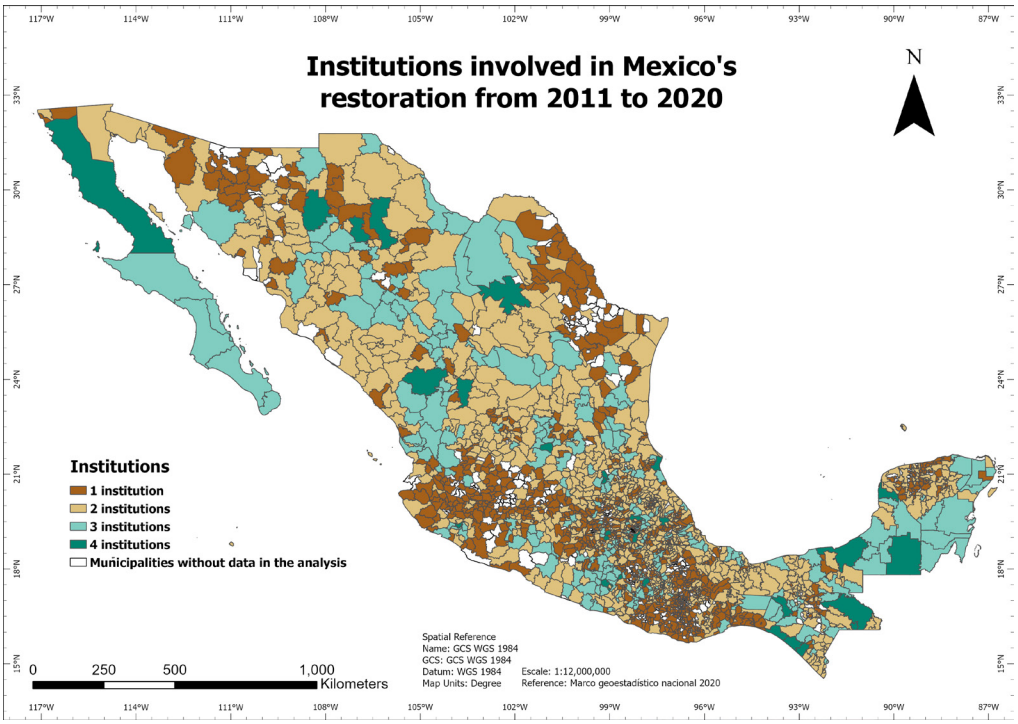

Figure 6 Municipalities with restoration actions and number of institutions that carried out activities (2011-2020).

Source: Own elaboration.

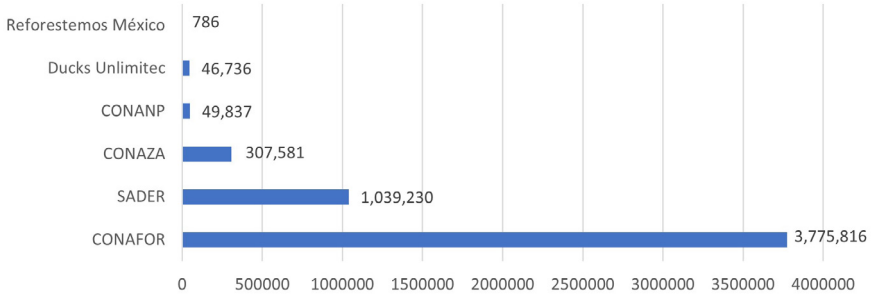

Figure 7 Restored area distribution in the decade, per institution.

Source: Own elaboration.

Table 8 Spatially explicit restoration projects and intervention areas in natural vegetation according to the ecosystem classification of the Restoration Barometer

Bonn ecosystem typology	Number of projects spatially explicit	Area (ha)
Coasts and mangroves	33	6219
Deserts and semi-deserts	1414	112016
Forests and woodlands	10733	413675
Grasslands, shrublands and savannahs	381	23342
Rivers, streams and lakes	28	2465
Farmland and mixed-use areas	9421	246423
Urban areas	fifteen	150
Others	twenty-one	1836

Source: Own elaboration.

Considering the size of the work polygons, 90% have surfaces of less than 100 ha. It must be highlighted that of the total (22,046), only 6 polygons have surfaces which are broader than 500ha. And, of all of these, only one is above 1000 ha. Therefore, based on the information analyzed, there is a high concentration of actions on small areas (Figure 9).

Annex VIII indicates the area and the number of projects for each entity of the Mexican Republic based on spatially explicit data. The most significant amount of spatially explicit restoration polygon projects under analysis linked to restoration is found in the state of Veracruz (2,638) (Figure 10). While the largest restored area, taking those into consideration, occurred during the decade 2011-2020 in Guerrero (70,079.9 ha) (Figure 11). Notice that although in the latter there is less than half of restoration projects than in the first (1,059), it exceeds by more than 100% the total area intervened (the site restored in Veracruz for the decade is 25,658 ha).

The specific activities carried out in each of the projects analyzed and their corresponding databases, were categorized into four large groups: Restoration, Reforestation, Maintenance of intervened areas, and Implementation of agroforestry systems. These correspond, under the RITTE to artificial regeneration, land / water protection, conservation actions, planted forest and woodlots. Although restoration was the first

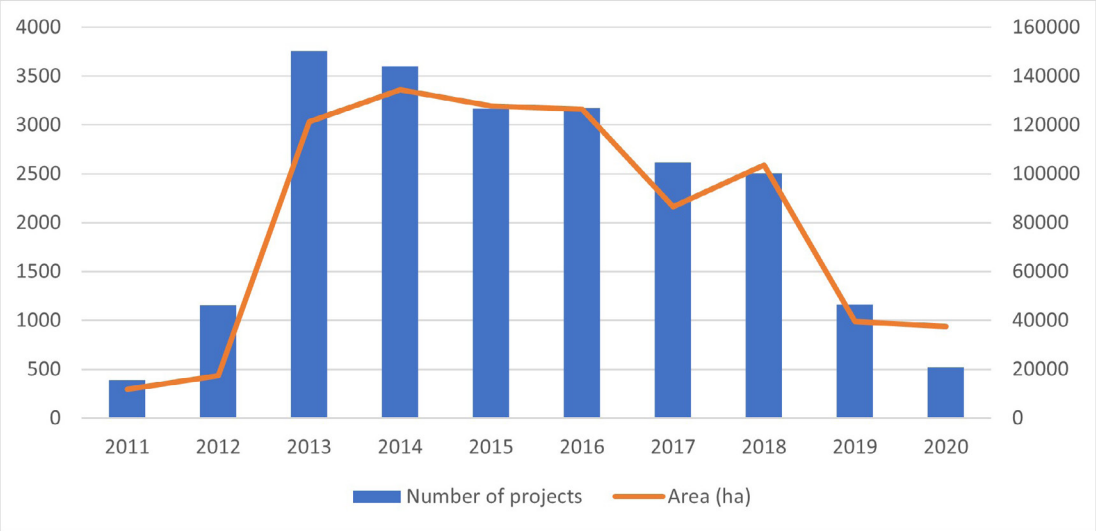

Figure 8 Spatially explicit restoration projects and intervened areas in the decade 2011–2020.

Source: Own elaboration.

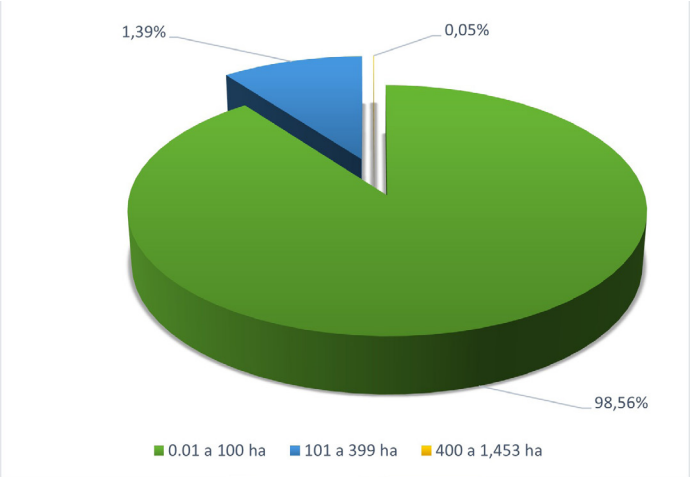

Figure 9 Percentage distribution of spatially explicit polygons based on intervention areas.

Source: Own elaboration.

in several projects, it was the second concerning the impacted area, having been surpassed by reforestation with 343,891 ha and 426,375 ha, respectively. The activity with the lowest number of projects was the maintenance of restored or reforested areas. In contrast, the implementation of agroforestry systems covered the smallest area, with barely 17,319 ha (Figure 12).

Financing

Of MXN 60,911,159,022 equivalent to 2020 (equivalent to USD 2,834,395,487 in 2020), SADER is the institution that allocated the most resources to restoration actions, followed by CONAFOR and CONAZA (Table 9). No data was obtained on the total investment made by non-governmental institutions.

Two of the three municipalities where the most investment in restoration actions was accumulated in the decade are in the state of Chiapas; the third one belongs to Tabasco. Additionally, these municipalities account for barely 0.3% of the amount allocated to restoration in the country during the analysis period, which shows that the dispersion of resources relative to restorative actions has been high (Table 10).The municipalities where the least investment was made were Tubutama in Sonora, followed by Santiago Choápam and San Juan Comaltepec in Oaxaca (Table 11).

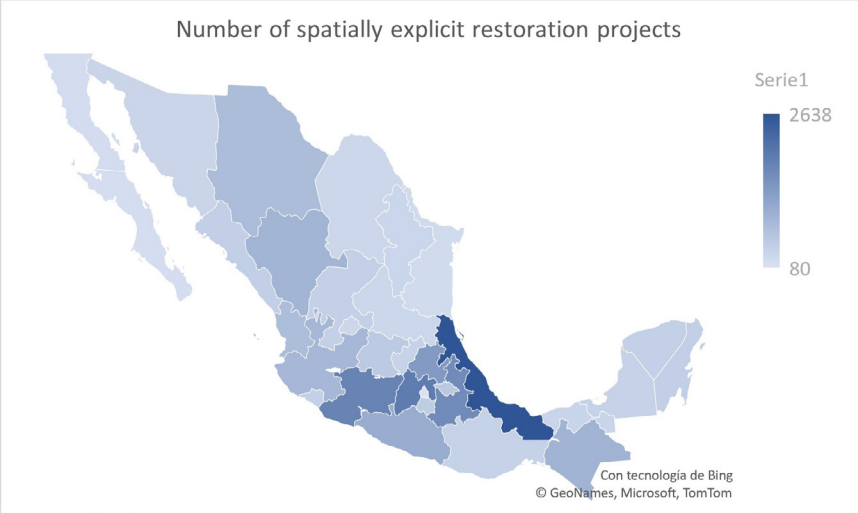

Figure 10 State distribution of spatially explicit restoration projects.

Source: Own elaboration.

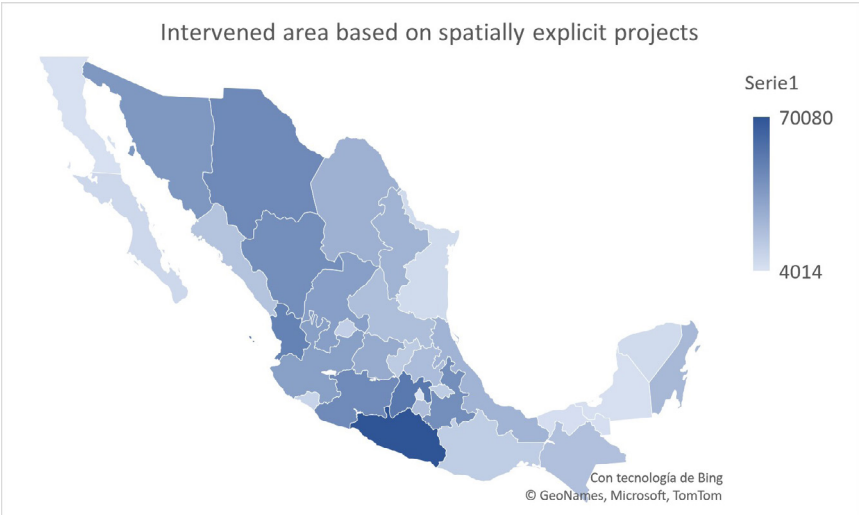

Figure 11 State distribution of intervention areas based on spatially explicit projects.

Source: Own elaboration.

In the following image (Figure 13), it is possible to appreciate, per municipality, the total investment accumulated in the decade.

The Mexican southeast and northeast of the country stand out, mainly as a result of the actions generated by SADER and CONAFOR, respectively.

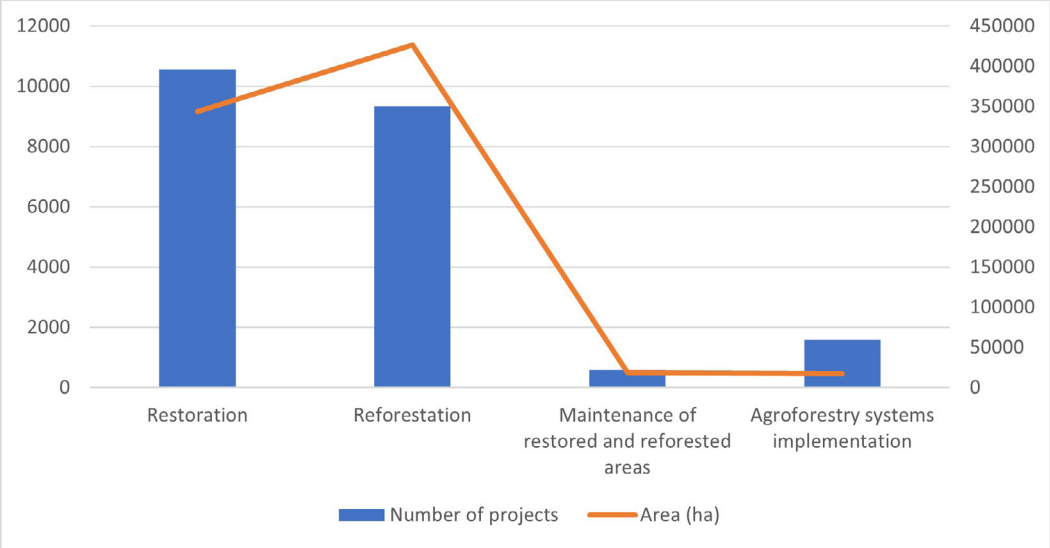

Figure 12 Number of spatially explicit projects and areas of intervention by type of activity carried out.

Source: Own elaboration.

Figure 13 Cumulative investment in the decade by municipality.

Source: Own elaboration.

Table 9 Distribution of investment in restoration actions by institution

Institution	MXN investment equivalent to 2020	USD investment equivalent to 2020
3.5013 cm	37,883,985,000	1,762,865,752
CONAFOR	20,823,959,039	969,006,935
CONAZA	2,031,474,915	94,531,173
CONANP	171,740,068	7,991,627

Source: Own elaboration.

Table 10 Main municipalities in relation to accumulated investment

Municipality	Accumulated investment equivalent to 2020 (MXN)	Accumulated investment equivalent to 2020 (USD)
3.5013 cm	1,978,606,799	92,071,046
Balancan (Tabasco)	1,281,215,597	59,619,153
Palenque (Chiapas)	867,188,360	40,353,111

Source: Own elaboration.

Table 11 Municipalities with less investment in the decade

Municipality	Accumulated investment equivalent to 2020 (MXN)	Accumulated investment equivalent to 2020 (USD)
3.5013 cm	8,683	404
Santiago Choapam	10,832	504
San Juan Comaltepec	10,832	504

Source: Own elaboration.

Differentiation in financing sources of the restoration actions developed in Mexico during the period 2011–2020

The primary source of financing is domestic public spending since the analysis is based on public institutions and their restoration programs. Just as with the total amount of projects, and contrary to what happens with the area, SADER has made the most investment in restoration, followed by CONAFOR with values of 62% and 34%, CONAZA and CONANP with 0.3% each (Figure 14).

Public spending related to environmental protection and restoration in Mexico during the 2011–2020 period

According to data published by SEMARNAT on the portal of the National System of Environmental Information and Natural Resources[10], related to "Environmental protection expenses of the public sector," MXN 1,209,653,000,000 (USD 56,289,111,215) were invested under this concept during the decade.

Taking into consideration the estimation of the total resources allocated to restoration and the reference mentioned above, this means that an equivalent to 5% of all public resources allocated to environmental protection was earmarked for restoration initiatives.

Economy

Jobs created by restoration

According to the procedure described in the economy section of the methodological area, 72 different restoration actions were identified in the RITTE. However, not all of them are present in the records of restoration activities developed between 2011 -2020. For each one, the number of wages per hectare was determined to facilitate future information updates. Thus, based on annual implementation exercises, the actions of cleaning and revegetation with seed, as well as weeding, were the ones that represented the least investment of wages,

10 https://www.gob.mx/semarnat/acciones-y-programas/sistema-nacional-de-informacion-ambiental-y-de-recursos-naturales

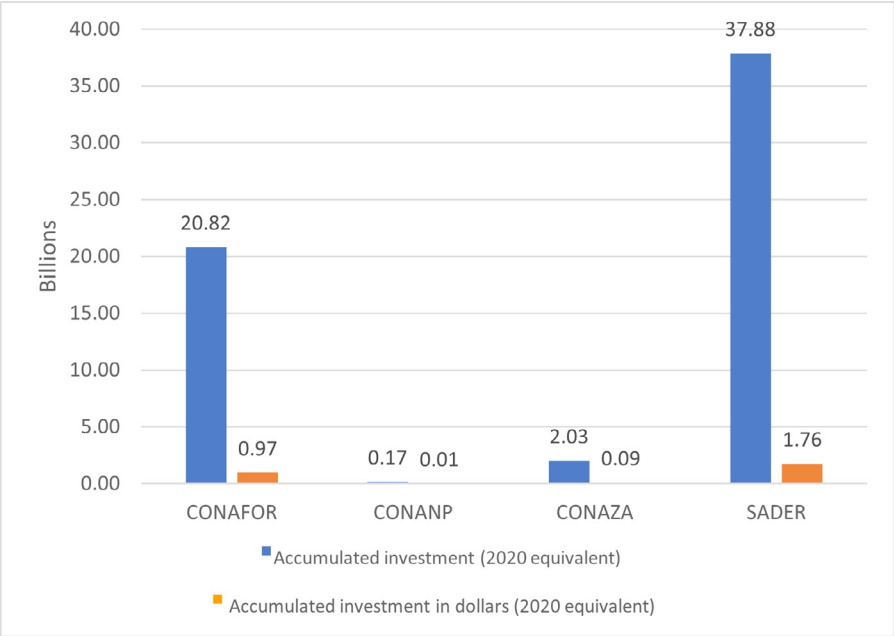

Figure 14 Investment in percentage by institution.

Source: Own elaboration.

with 0.3, 0.5, and 3 wages per hectare, respectively. For their part, the most labor-intensive activities are soil conservation and canal management, with 70 and 194 wages/ha/year each (see details in Annex VI).

Based on these values and the classification of activities related to each restoration project involved in this work, the total number of casual jobs generated in the decade was determined[11]. It amounts to 1,822,491 casual jobs for the 2011-2020 decade.

The activity that generated the most jobs was forest farming in timber harvesting (CONAFOR) with just over 652,139, followed by the agroforestry modules (SADER) with 258,476 see Table 12.

The ten main activities are presented in the following Table based on the number of jobs generated. These represent 94% of the calculated casual jobs.

Considering the number of jobs generated by each type of restoration action, it is possible to appreciate that: silviculture generated 48%, artificial regeneration activities 28%, and agroforestry /silvopastoral system 14%.

However, activities such as forest plantation and the maintenance of reforested areas have presented a continuous creation of wages, although with a recent downward trend. Others, such as the creation of agroforestry modules, did not appear in the entire decade, but they have generated, especially in recent years, a large number of jobs.

Municipalities under condition of poverty

Restoration can also be understood as a way to increase the natural capital and, from there, the communities' productive, financial, social, and human capital to reduce their socio-environmental vulnerability. For this reason, evaluating the incidence of restoration actions, superficially and in terms of their investment, concerning the population living in poverty is essential.

The restoration activities in the decade show a low relationship (Pearson's correlation index= 0.04) between the impacted area and the percentage of the population living in poverty and extreme poverty in the municipalities where there was an incidence. The same occurs between the amount of the investment destined for restoration and the municipalities with the most significant presence of population under the conditions in question (Pearson's correlation index = 0.05).

Indigenous municipalities

Only 23 of the 2,088 municipalities with restoration activities in the decade do not have an Indigenous population. The rest show a differentiated degree of presence of the native population. In those places where there were restorative actions,

11 As mentioned in the introductory and methodological section, the restoration actions generate in most jobs of this nature, therefore this was the homologous category used.

63% are classified as having a dispersed Indigenous population, and 26% are fully Indigenous territories (Table 13).

In the latter, 182,160 projects are reported in the decade, accumulating a restored area of 932,441 Ha, representing about a fifth of the total restored area (18%). The restoration activities executed in these territories were: agroforestry modules, reforestation, and maintenance of reforested or restored areas (Table 14).

Studies such as those conducted by Boege (2010) have shown that an essential proportion of the nation's natural capital and biodiversity are protected in the country's Indigenous territories. However, this does not exclude them from the need to carry out restorative actions. Its inclusion in these processes is key to achieving the country's environmental commitments. As seen in this analysis results, this is of considerably high relevance and amounts to about a fifth of what was achieved in the decade.

Municipalities with the largest area identified as priority for restoration

Taking into consideration that the restorative actions analyzed for the decade were carried out in about 85% of the country's municipalities, it was possible to identify by overlapping geographic layers that, of these, 96% have priority areas for this activity, which that in principle reveals a high concordance

Table 12 Main restoration activities and jobs generated

Restoration activity	Equivalence under the RITTE	Number of casual jobs
Forest cultivation in timber exploitation	Silviculture	652,139
Agroforestry modules	Agroforestry / silvopastoral system	258,426
Comprehensive restoration	Artificial regeneration	219,587
Restoration	Artificial regeneration	195,474
Commercial forest plantations	Silviculture	123,819
Soil Conservation and Restoration	Soil and water protection / Conservation actions	78,645
Fire management actions	Silviculture	61,347
Reforestation	Artificial regeneration	54,011
Biodiversity conservation	Creation/enhancement of habitat for native wildlife species	35,872
Complementary restoration	Artificial regeneration	29,089

Source: Own elaboration.

Table 13 Categorization of the Indigenous population at the municipal level and restoration actions in the decade

Type of presence of indigenous population	Number of municipalities with restoration activities in the decade
Population with Indigenous presence	225
Indigenous population	535
Dispersed Indigenous population	1305
No Indigenous population	23

Source: Own elaboration.

Table 14 Restoration activities and number of projects in Indigenous municipalities

Restoration Activity	Typological equivalence of the Restoration Barometer	Number of projects in Indigenous municipalities
Agroforestry Modules	Agroforestry systems	162,322
Reforestation	Artificial regeneration	7,568
Maintenance of reforested or restored areas	Silviculture	3,184

Source: Own elaboration.

between the territorial demarcations with surfaces that need to be restored and the direction of activities destined to it.

In addition, there is a Pearson correlation index with a magnitude of 0.26 that reveals a positive, albeit weak, linear trend between the geographical priorities for restoration and effective restored areas.

Biodiversity

Municipalities with the largest area allocated to conservation

There is a positive correlation, although small, with a magnitude of 0.33, between the municipalities with the largest restored area and those with the most significant areas designated for conservation, see Figure 15. The nature of the spatially explicit data limits the possibility of knowing the degree to which the restorative actions are concentrated precisely in the protected areas. However, it is possible to indicate an initial tendency towards it. More details about the restoration actions and PA are presented in the following sections.

Municipalities with the greatest change in ecological connectivity

As stated in the methodological section, the change in municipal connectivity has been identified by comparing the patches of original vegetation from series 5 and 7 of INEGI and the application of formula 3. Only 438 (21%) of the 2088 municipalities, where there were restoration actions in the decade, presented a gain in their connectivity, 5 (0.2%) remained the same, while the rest, 78.8%, lost connectivity. There is a fragile positive correlation index (magnitude=0.1) between the restored area and those municipalities that gained connectivity. Considering all the municipalities, there is no correlation between both variables (Pearson's correlation index magnitude= -0.002).

Area under restoration in protected areas

On the other hand, considering the overlapping of layers made between the protected natural areas of the country (PA) and the work polygons for the decade, as well as the data from records in which, without having a polygon, it is certain that they correspond to PA (see methodology and annex V). In total, 3,369 projects in protected areas were considered. This area represents 176,178.82 ha, 0.66% of the whole PAs in Mexico, and 22% of the total area restored in the decade for which spatial information was obtained.

From this information base, it is possible to identify which restoration actions were carried out in 193 of 964 PAs considering Federal, State, Municipal, and Voluntarily Destined Areas for Conservation, equivalent to 20% of them.

The highest incidence of work polygons within PA is recorded in Secondary Vegetation types, followed by Forest and Grassland. However, in simple terms, the Forest ecosystem reports the most significant number of hectares with restoration actions, 19,994. (Figure 16).

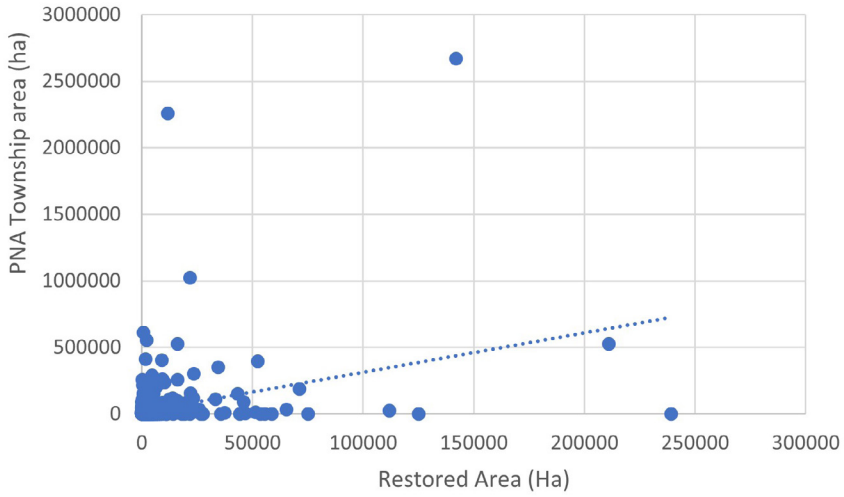

Figure 15 Relationship between the restored areas and the municipalities with the largest area designated for conservation.

Source: Own elaboration.

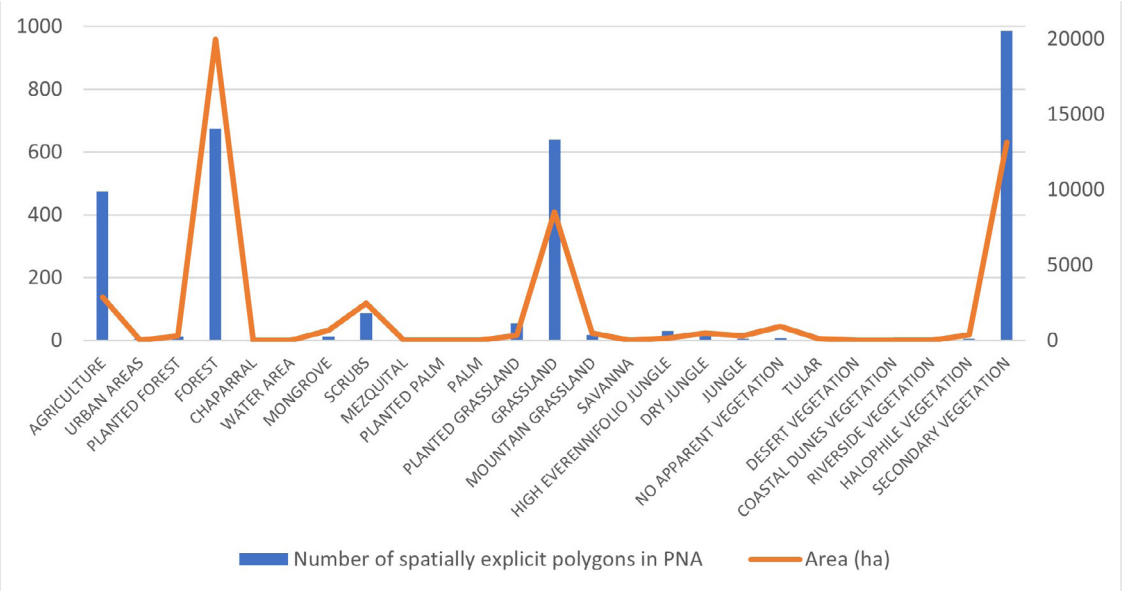

Figure 16 Restoration actions in types of vegetation within PAs based on spatially explicit projects.

Source: Own elaboration.

Area under restoration in natural ecosystems

According to the work polygons, the highest incidence of restoration actions during the decade (number of projects) occurred in areas of secondary vegetation, agriculture, and forest. Actually, these categories simplify the 127 land uses identified by INEGI, in which, among others, the 56 classifications have been grouped under secondary vegetation, 14 correspond to agriculture, and 9 in forest types present in the country.

Thus, 34% of the total area under restoration for which there is spatial information is equivalent to 273,696 ha which overlap with primary vegetation. The areas are distributed in 5353 projects. Forest, Grassland, and Scrub were the most benefited ecosystems, while the least were the riverside vegetation, natural palm grove, and vegetation of sandy deserts. Table 15 shows the number of projects for each contemplated category.

Annex VII includes the table of equivalences between land uses and vegetation in the country and the RITTE. Using that Table, it can be seen that the largest area of original vegetation restored occurred in the decade within the ecosystem classified as Forests and trees and the least in Rivers, streams, and lakes.

Restored area in Key Biodiversity Areas

Regarding the critical areas for conserving biodiversity KBAs, there are 288 in Mexico. These represent fundamental sites for the maintenance of species at a global level. They have been identified through a series of internationally coordinated criteria that summarize decades of experience in conservation processes throughout the planet (IUCN, 2016).

The KBAs cover an area of 40,848,279 ha in the country. According to the work polygons, 5,191 projects benefited KBAs during the decade, which covers 80,068 Ha. This represents 0.19% of the area categorized as KBA, 10% for which polygons were obtained, and 2% of the total restored area. However, this last result must be considered carefully since the percentage could be higher since spatial data of 100% of the restorative actions of the decade have not been accessed.

The incidence of restoration actions in KBA was higher during 2013 and then gradually decreased until it reached magnitudes similar to those at the beginning of the decade. This behavior is similar to that of all spatially explicit polygons. On the other hand, the most significant number of restoration actions within the KBAs is associated with the Forest ecosystem, as well as the largest impacted area, followed, by the grassland (Table 16).

Threaten species benefited by restoration in the decade

In the analysis to determine the impact of restoration actions on threatened species with an active conservation program (see the methodological section for more detail), 54 priority species in the country were considered. Of these, 45 had records in Mexico's continental, coastal and insular areas, amounting to a total of 28,190. However, only 22,260 records

Table 15 Primary vegetation with the highest incidence of restoration projects in the decade based on spatially explicit information.

LAND USE AND VEGETATION	POLYGONS	AREA (Ha)
Riverside vegetation	1	8
Natural palm grove	1	47
Vegetation of sandy deserts	2	237
High evergreen forest	44	262
Coastal dune vegetation	7	293
Savannah	28	513
Chaparral	55	1,887
Tulle	21	1,961
High mountain meadow	18	2,233
Halophytic vegetation	40	3,680
Medium jungle	94	4,437
Mangrove swamp	22	5,526
Mesquital	52	8,897
Low jungle	221	10,401
Scrub	1014	78,217
Forest	3733	155,097
Total	5353	273,696

Source: Own elaboration.

had a permeability area, which means that half or more of the vegetation there, in a diameter of 3 km around, presents displacement resistance values equal to or less than 50%. There were 474 permeability radii where restoration actions were registered in the decade, corresponding to a total of 32 species, in other words where the habitats of taxa were positively impacted by restoration.

The trans volcanic rattlesnake (Crotalus Triseriatus) and the zacatuche rabbit (Romerolagus diazi) were the species whose habitat benefited the most from restoration. Figure 17 presents the distribution of actions by species.

In total, 31% of the species whose habitats was enhanced or regenerated by restoration (10 taxa) present some degree of endemism, while 28 (87%) are categorized in the "Norma Oficial Mexicana 059 SEMARNAT 2010"[12]. Most of these, 17, in danger of extinction (figures 18 and 19).

The IUCN Red List includes 31 species; 11 of them (34%) are in danger, surpassed only by those considered of Least concern; 12 species equivalent to 38% had their habitat enhanced or regenerated by restoration (Figure 20). Annex IX offers the list of taxa and their different risk categories.

Table 16 Incidence of spatially explicit projects in KBA

Land use and vegetation	Work polygons with incidence in KBA	Area (ha)
Agriculture	1092	6736
Human settlements	5	6
Cultivated forest	3	85
Forest	1135	28278
Chaparral	35	782
Water body	2	43
Mangrove swamp	16	630
Scrub	138	6338
Palmar induced	6	237
Natural palm grove	1	15
Cultivated grassland	158	1428
Pastureland	572	7482
High mountain meadow	14	292
Savannah	5	35
High evergreen forest	20	89
Low jungle	35	1170
Medium jungle	14	645
No apparent vegetation	8	922
Tulle	17	387
Halophytic vegetation	6	266
Secondary vegetation	1909	24202

Source: Own elaboration.

12 This standard identifies the species or populations of wild flora and fauna at risk in the Mexican Republic.

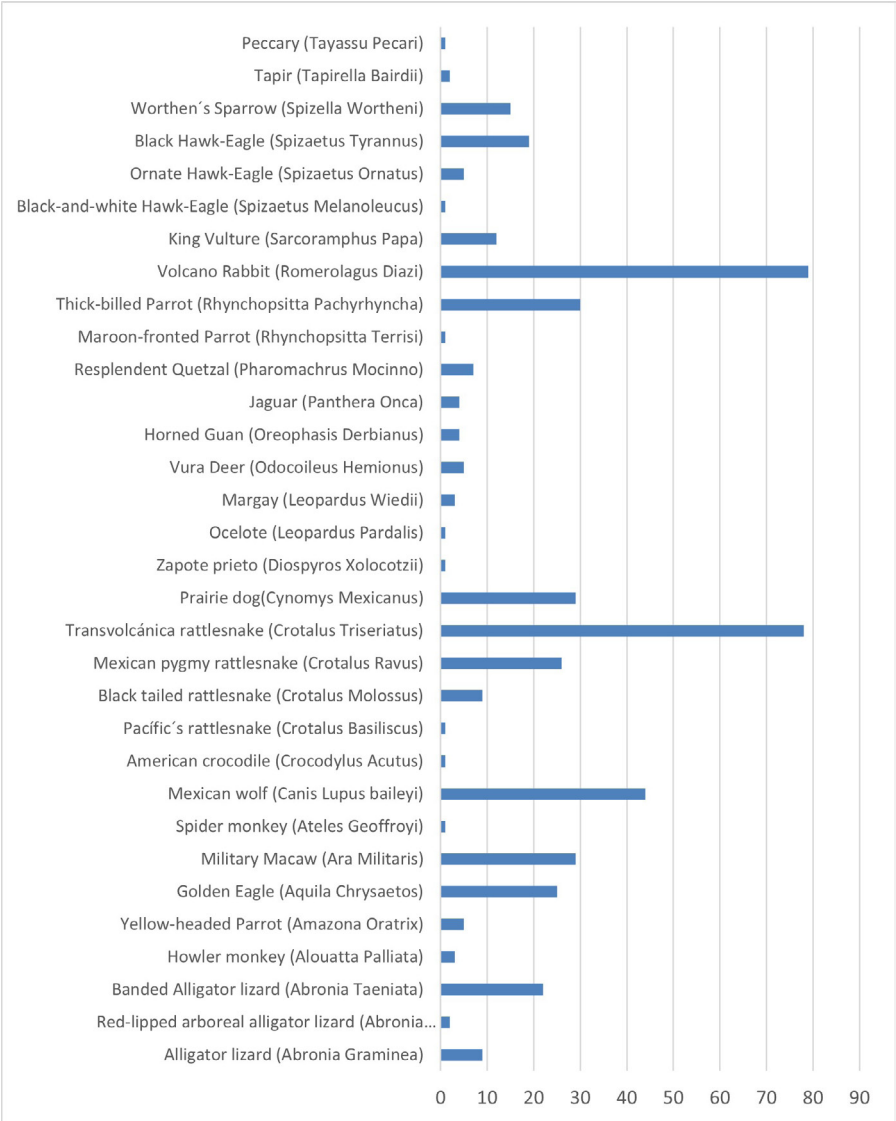

Figure 17 Number of spatially explicit projects with incidence in permeability radii of key species.

Source: Own elaboration.

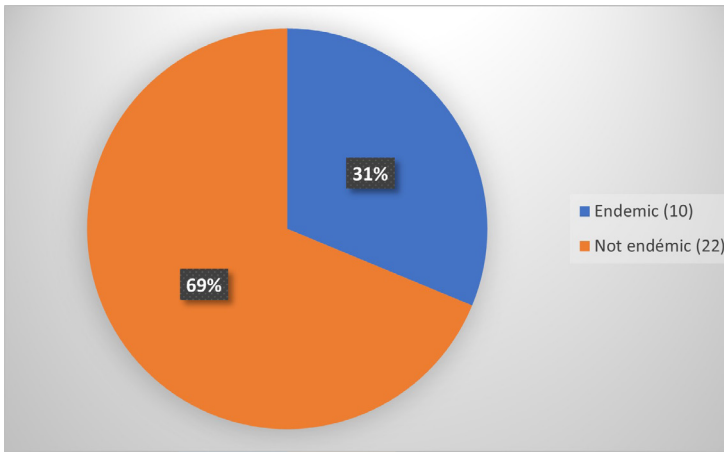

Figure 18 Endemism with respect to species whose habitats were enhanced by restoration.

Source: Own elaboration.

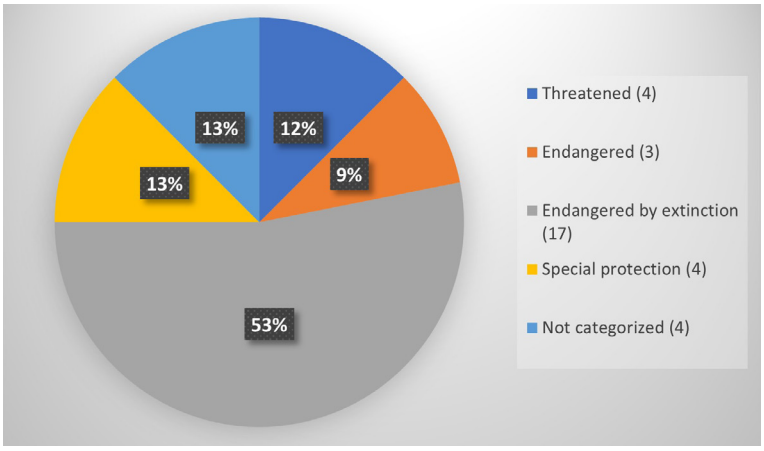

Figure 19 Categorization in NOM 059 of the species whose habitats were enhanced by restoration.

Source: Own elaboration.

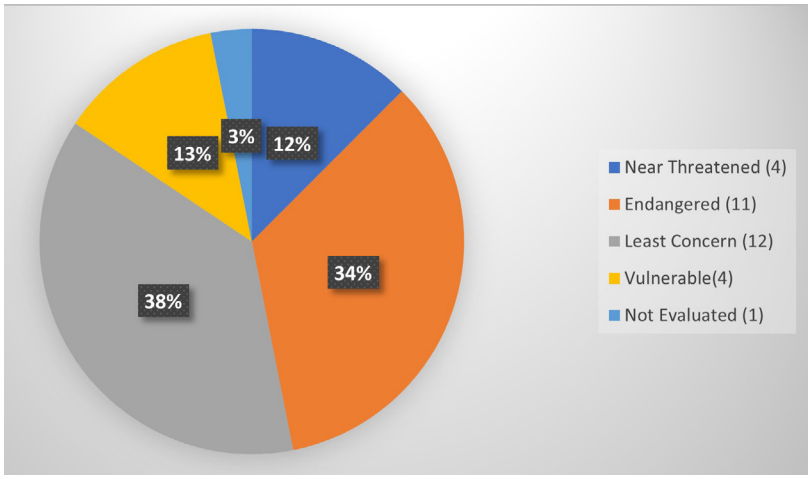

Figure 20 Categorization in the Red List of the species whose habitats were enhanced by restoration.

Source: Own elaboration.

It was estimated that 23,600ha have benefited from direct or indirect conservation, based on the species with conservation priority that presented restoration actions in their permeability radii and given the area associated with each.

This represents 2.9% of the area where there are spatially explicit polygons and 2.1% of the total restorative actions related to them.

The trans volcanic rattlesnake (Crotalus Triseriatus) was the species whose habitat benefited the most from restoration; followed by the western mountain parrot (Rhynchopsitta Pachyrhyncha), the first with 5,046 ha and the second with 2,424 ha. Figure 21 shows the distribution of hectares with restoration actions in the permeability radii for each species.

Climate

One raster layer of the SOC was obtained at national level in line with the methodological process for calculating CO_2 captured in the sites where restoration actions took place. Figure 22 illustrates the variation of SOC across Mexico for the year 2011.

The layer presented a total of 27,506,923 pixels with differentiated SOC values. However, these include ranges from 0-691 metric tons per hectare, the value of the averages of the pixels related to each land use, and the simplified classifications of this used for determining changes in carbon are shown in Annex X.

Additionally, Annex X shows the ecosystems and their respective CO_2e based on the difference in SOC and the totals for the analyzed decade.

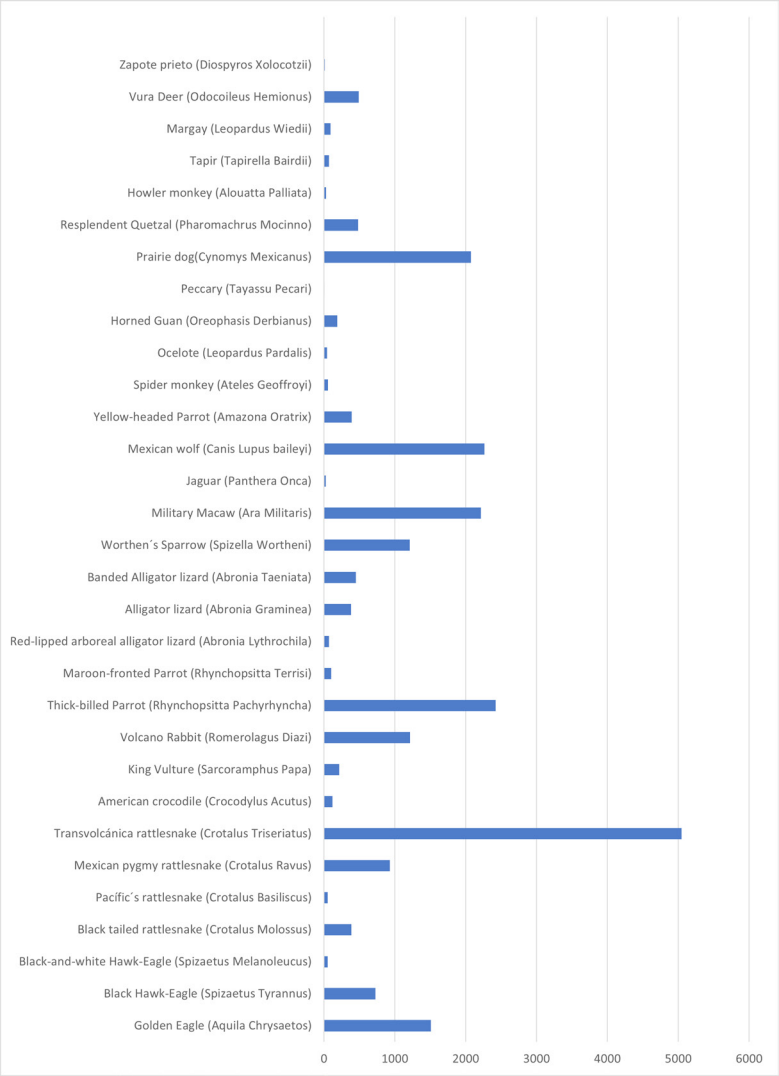

Figure 21 Distribution of hectares with restoration actions in the permeability radii per species.

Source: Own elaboration.

Annex XI shows the FIABA obtained concerning the aerial biomass and its carbon fraction. Based on these, the ecosystem that collected the most and the least CO_2 after the modifications in the land uses of the work polygons[13], were shrubby secondary vegetation and forest with 1,054,466 and -116,844, respectively. The presence of negative values may indicate that, despite the restoration actions undertaken, the degradation derived from the change in land use, primarily in forest areas, exceeded the capture rate. The total CO_2e related to this reservoir is 231,348 Ton CO_2e.

Table 18 shows the various simplified classifications, their carbon differential based on fluctuations in above-ground biomass, and the CO_2e relative to it.

Considering both the organic carbon in the soil and the carbon associated with aerial biomass, the total estimated tons of CO_2e for the decade is 3,974,622. Table 19 shows Mexico's final values related to each type of simplified ecosystem. As in the previous cases, the shrubby secondary vegetation is the one that accumulates most of the total CO_2, while the forest accumulates the least.

Municipalities with high vulnerability to climate change

SEMARNAT has identified 273 municipalities of priority attention due to vulnerability to climate change, of which 84% (228) benefited from restoration actions in the decade. In these, the accumulated restored surface has been 418,958 ha.

13 For detailed sources of information used to determine changes in land use, see the methodology section on climate.

The three main restoration activities carried out in these municipalities throughout the decade are silviculture cultivation in timber harvesting with 35%, reforestation with 17%, and agroforestry modules with 15%.

Table 17 Main ecosystems in relation to their differential in SOC between 2011 and 2020

Classification of land uses and vegetation	Differential in SOC (Ton)
Shrub secondary vegetation	1,862,567.68
Cultivated grassland	182,894.63
Tree secondary vegetation	143,177.26
Induced grassland	-346,449.95
Agriculture	-350,908.19
Forest	-710,994.65

Source: Own elaboration.

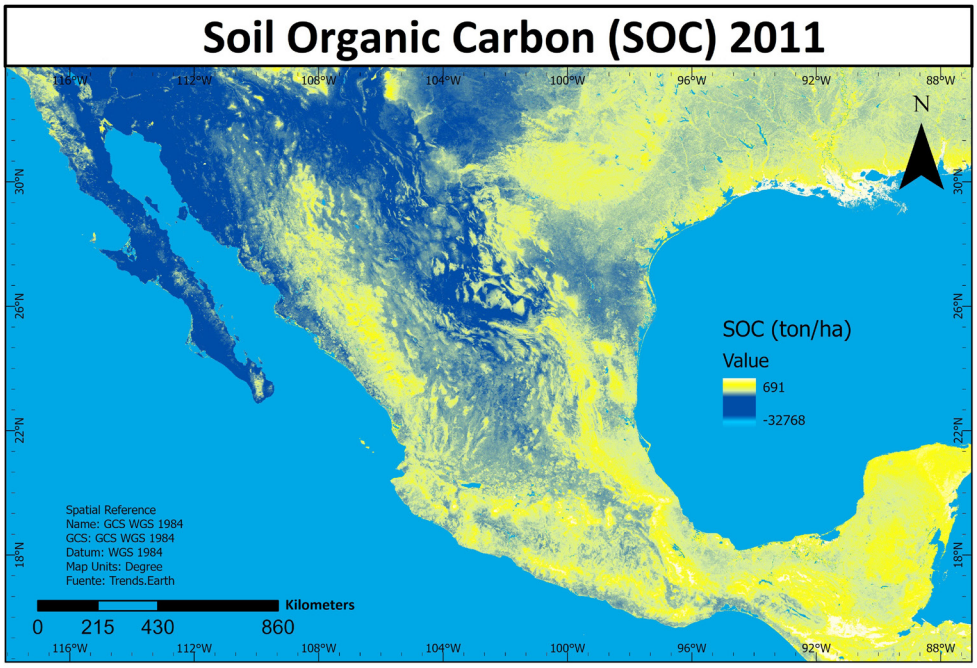

Figure 22 SOC 2011. Data from Trends Earth.

Source: Own elaboration with data from Trends.

Table 18 Ecosystems of Mexico with their accumulated aerial carbon difference based on annual growth factors, as well as their CO_2 equivalence

ECOSYSTEMS	ACCUMULATED AIR CARBON DIFF (TON)	DIFF CO_2e EQUIVALENT (TON)
Aquaculture	0.00	0.00
Agriculture	-49,065.30	-180,069.66
Human settlements	3,644.39	13,374.91
Forest	-116,844.31	-428,818.62
Cultivated forest	5,109.73	18,752.71
Induced forest	0.00	0.00
Chaparral	-6,573.88	-24,126.13
Water bodies	0.00	0.00
Devoid of vegetation	0.00	0.00
Mangrove swamp	0.00	0.00
Scrub	-32,732.75	-120,129.18
Mesquital	-7,156.56	-26,264.56
Palmar induced	3,974.00	14,584.56
Natural palm grove	0.00	0.00
Cultivated grassland	13,207.85	48,472.80
Gypsophila grassland	0.00	0.00
Halophilic grassland	0.00	0.00
Induced grassland	-38,439.04	-141,071.27
Natural grassland	-4,868.23	-17,866.41
Popal	0.93	3.40
High mountain meadow	5,989.10	21,979.99
Savannah	292.43	1,073.21
Sabanoid	-774.99	-2,844.22
Jungle	16,647.33	61,095.70
No apparent vegetation	0.00	0.00
Tulle	70.42	258.46
Vegetation of sandy deserts	0.00	0.00
Coastal dune vegetation	0.00	0.00
Riverside vegetation	-222.31	-815.88
Peten vegetation	7.54	27.65
Gypsophilous vegetation	0.00	0.00
Hydrophilic halophilic vegetation	0.00	0.00
Xerophytic halophytic vegetation	0.00	0.00
Tree secondary vegetation	-21,123.07	-77,521.66
Shrub secondary vegetation	287,320.40	1,054,465.89
Herbaceous secondary vegetation	6,045.52	22,187.05
Urban zone	-1,471.50	-5,400.42
TOTAL	63,037.69	231,348.32

Source: Own elaboration

Table 19 Difference in CO_2 e in the decade, based on soil organic carbon and accumulated annual growth of aerial biomass per ecosystem type.

ECOSYSTEMS	DIFF CO_2 EQUIVALENT BASED ON SOC	DIFF CO_2 EQUIVALENT BASED ON ACCUMULATED AERIAL BIOMASS GROWTH	CO_2 e Calculated Total
Aquaculture	0.65	0.00	0.65
Agriculture	-1,287,833.07	-180,069.66	-1467902.73
Human settlements	52,314.73	13,374.91	65689.64
Forest	-2,609,350.37	-428,818.62	-3038168.99
Cultivated forest	69,673.89	18,752.71	88426.6
Induced forest	0	0.00	0
Chaparral	-136,671.00	-24,126.13	-160797.13
Water bodies	112,008.27	0.00	112008.27
Devoid of vegetation	23,701.99	0.00	23701.99
Mangrove swamp	136,774.34	0.00	136774.34
Scrub	-612,764.23	-120,129.18	-732893.41
Mesquital	-22,204.31	-26,264.56	-48468.87
Palmar induced	144,165.38	14,584.56	158749.94
Natural palm grove	0	0.00	0
Cultivated grassland	671,223.28	48,472.80	719696.08
Gypsophilous grassland	0	0.00	0
Halophilic grassland	0	0.00	0
Induced grassland	-1,271,471.30	-141,071.27	-1412542.57
Natural grassland	-142,043.43	-17,866.41	-159909.84
Popal	1,296.67	3.40	1300.07
High mountain meadow	378,392.60	21,979.99	400372.59
Savanah	18,593.65	1,073.21	19666.86
Sabanoid	-16,970.00	-2,844.22	-19814.22
Jungle	432,448.60	61,095.70	493544.3
No apparent vegetation	-52,463.07	0.00	-52463.07
Tulle	221,140.89	258.46	221399.35
Vegetation of sandy deserts	0	0.00	0
Coastal dune vegetation	-10,379.94	0.00	-10379.94
Riverside vegetation	-2,220.97	-815.88	-3036.85
Peten vegetation	8,496.67	27.65	8524.32
Gypsophilous vegetation	0	0.00	0
Hydrophilic halophilic vegetation	21,765.69	0.00	21765.69
Xerophytic halophytic vegetation	-30,827.98	0.00	-30827.98
Tree secondary vegetation	525,460.55	-77,521.66	447938.89
Shrub secondary vegetation	6,835,623.37	1,054,465.89	7890089.26
Herbaceous secondary vegetation	306,994.46	22,187.05	329181.51
Urban zone	-21,601.98	-5,400.42	-27002.4
TOTAL	3,743,274.02	231,348.32	3,974,622.34

Source: Own elaboration.

8 Final reflections

- In the international context, different agreements focused on restoration have been developed, the most important agreements have been signed by Mexico.
- The Mexican regulatory framework related to restoration has been developing throughout the last century to the present day, with laws, international agreements, secondary laws, and regulations dealing with restoration. However, it is recognized by different actors involved in restoration that it is necessary to strengthen it and promote long-term public policies, improving resources where restoration actions are required.
- Regarding public policies on restoration in Mexico, it is observed that throughout the decade, it underwent variations. In a few years, there were specific restoration programs for certain regions of the country, such as the special programs Pátzcuaro and Zirahuén, Cutzamala, Federal Forest Meseta Purépecha, PRODESNOS, DECOFOS, Coastal Basins in the State of Jalisco, Conservation, Restoration and Sustainable Use of the Lacandona Forest, and the PEPY among others. Therefore, the change and evolution of different programs were identified throughout the decade. See Annex III.

  It should be noted that public programs linked to restoration were found in agriculture and social sectors, so they must be considered, and their contribution to the subject should be evaluated in greater detail.

- In general, the number of projects with restoration actions per institution per year has decreased. However, the accumulated number of actions shows a peak of projects in 2019 marked mainly by activities linked to agroforestry, even after a decrease in work associated with the topic. In general, the impact on strategic areas such as priority conservation zones, municipalities with a more significant Indigenous presence, municipalities vulnerable to climate change, or regions categorized as essential for silviculture production, reports medium to low correlation values with the restored surfaces, which represents an important area of opportunity in the future.
- The restoration analysis presents challenges in Mexico, ranging from obtaining information from the institutions in charge of the subject to the reliability of the data. When geospatial data are lacking, it becomes impossible to locate all sites where restoration actions are carried out, hence limiting the results obtained from GIS analysis (e.g. biodiversity, climate impacts). In the case of getting geospatial data, they must go through a review and consolidation process.
- Likewise, there must be a precise and articulated nomenclature of unique identifiers (ID) linked to the restoration activities, between institutions involved. Indeed, the repetitions of IDs generate an additional and significant consolidation effort to avoid double counting intervened areas.
- Restoration actions in Mexico, during the decade of analysis, have presented a very varied profile in terms of activities. However, the recent incorporation of institutions, such as SADER, in restoration has quickly led to weighing actions related to agroforestry as to which most investment is devoted. On the other hand, institutions historically linked to restoration processes, such as CONAFOR in the last years of the decade, have changed the destination of their resources with a greater focus on forest productivity.
- Up to the date of this report, it has been particularly complex to obtain information on the subject of non-governmental organizations and the private sector. It is crucial

to improve intersectoral links with a view to a unified repository of restoration information in Mexico that will give rise to complementary analyzes in the future.

- The variability of the data, units, and reporting formats for the actions related to the restoration tasks, which derive from the multiple institutions analyzed in this study, demonstrates a lack of coordination on the subject, which affects the quality of the data, likely to be analyzed for further evaluation. However, it has been possible to identify that the agroforestry and reforestation modules are the two main actions developed in the decade. The center, southeast, and northwest of the country, particularly in the peninsular states, have been the places with the greatest concentration of investment. They are also the places where a more significant number of institutions converge to carry out projects associated with restoration.
- The analysis of data showed that 27 different types of restoration interventions were implemented in more than 80% of the country's municipalities. Such data may represent a good percentage, but having enough information to validate its effectiveness in coverage and its impact on the municipalities, can generate better decision-making.
- In fact, of the 493,826 restoration interventions registered throughout the 2011-2020 decade, which add up to 5,219,986 ha, the projects with spatially explicit limits (polygons) represent 806,126 ha, that is, one-fifth of the total registered area.
- The effect of restoration actions on the types of ecosystems reveals a greater incidence in secondary vegetation, forests, and agricultural areas. However, particularly for forests, and considering exclusively the spatially explicit information, it is striking that a negative SOC and aerial Carbon value is presented. This fact could show that despite the large number of reforestations in the decade, it has not compensated for the degradation in these spaces. For this reason, a modest impact on climate change mitigation can be seen during the 2011-2020 decade (3.9M. TCO_2e) compared to the extension of the georeferenced restored areas (806,126 ha). Additionally, restoration activities have occurred in a very high percentage on plots that do not exceed 100 ha, so that, in general terms, restoration activities are spatially dispersed. This explains the low incidence in municipalities where ecological connectivity, interpreted from patches of the original vegetation, has increased or has been maintained.
- It is essential to have more spatially explicit references to better estimate the effect of restoration activities on threatened species or classified under some degree of risk. However, it was possible to identify that the most benefited species in terms of improved habitats as a result of restoration were the trans volcanic rattlesnake (Crotalus Triseriatus) and the zacatuche rabbit (Romerolagus diazi). Likewise, the habitat of 32 species prioritized by the country have improved. Of these, about a third are endemic, and just over half are in danger of extinction.
- It is necessary to be able to quantify the actions and investments of the private sector in restoration because they can generate significant contributions where public funds cannot be applied. The agricultural sector institutions represented more than 80% of restoration actions and CONAFOR 15%. However, CONAFOR exceeded 3.7 million hectares against just over 1 million from SADER. Therefore, the synergy between institutions could be interesting to obtain better results in terms of restoration.
- Due to the characteristics of the restoration actions, these generate casual jobs. They were estimated at 1,822,491 throughout the decade in relation to the 5,219,986 ha worked, which gives an average of 0.35 jobs per hectare. This value is higher than the international benchmarks consulted (0.2 jobs/Ha). The types of activities carried out, and the strong presence of agroforestry activities in the study could be influencing the result.
- The main source of investment for restoration in Mexico comes from public funds from the federal government, which has invested 60,911,159,022 pesos (US$2,834,395,487, value to 2020) throughout the analyzed decade, which is equivalent to 5% of the budget allocated for environment protection in the country. In the future, it is advisable to monitor the behavior of the investment destined both for the sector and restoration activities to determine specific needs to increase or redirect the resource.

In general, restoration work in Mexico presents excellent progress and important challenges for the coming years. For this reason, it is urgent to refine the direction of these actions towards priority areas and articulate the actions developed by the various institutions involved to maximize the synergy that could derive from the spatial concordance of service areas. Likewise, it is necessary to standardize reporting parameters between them to facilitate future analyzes to update this baseline. Only in this way can the effects of the tasks undertaken so far be evaluated and improve decision-making in this regard to have a positive impact on the ecosystems' conditions for humans and biodiversity.

Table 20 Main data related to restoration generated in the decade from 2011 to 2020

Concept	Quantity
Number of restoration projects	493,826
Hectares intervened	5,219,986
Casual jobs created	1,822,491
Total wages	242,598,358
Investment (pesos) equivalent to 2020	60,911,159,022
Investment (Dollars) Equivalent to 2020	2,834,395,487
Impacted municipalities	2,088
Soil organic carbon differential (Ton C) 2011-2020 (Based on spatially-explicit data)	1,019,966
Carbon differential in aerial biomass (Ton C) 2011-2020 (Based on accumulated annual growth and spatially-explicit data)	63,038
Equivalent CO_2 differential (Ton CO_2 e) captured 2011-2020 (Based on work polygons)	3,974,622
Number of key species benefited (Based on spatially-explicit data)	32

Source: Own elaboration.

Bibliography

Argüello H., Freyermuth G. y Gómez F. (2019). *Asignación presupuestaria para la prevención de uniones tempranas. El caso de SIPINNA y su Aplicación a nivel Federal, Estatal y Municipal*. México: Observatorio de Mortalidad Materna.

Banco Mundial (2022). *Inflación y precios al consumidor*. Disponible en: https://datos.bancomundial.org/indicator/FP.CPI.TOTL.ZG?locations=US

BenDor, T. K., Lester, T. W., Livengood, A., Davis, A., & Yonavjak, L. (2014). *Exploring and Understanding the Restoration Economy.* Final report to Walton Family Fund. https://curs.unc.edu/files/2014/01/RestorationEconomy.pdf

Bernal G., M. A. (2015). *Análisis y diagnóstico urbano-regional: metodología para la caracterización territorial, documento dirigido a estudiantes de arquitectura en el campo de conocimiento de urbanismo* / María Angélica Bernal Granados, colaboradoras Claudia López-Borbón, Dayra Vargas Ardila. Bogotá: Universidad Piloto de Colombia.

Boege, E. (2010). *El patrimonio biocultural de los pueblos indígenas de México. Hacia la conservación in situ de la biodiversidad y agrodiversidad en los territorios indígenas. Instituto Nacional de Antropología e Historia*. México: Comisión Nacional para el Desarrollo de los Pueblos Indígenas.

Bonn Challenge (2020). *Restore our future*. https://www.bonnchallenge.org/

Calva-Soto, K., & Pavón, N. P. (2018). La restauración ecológica en México: una disciplina emergente en un país deteriorado. *Madera y Bosques*, 24(1) e2411135. https://doi.org/10.21829/myb.2018.2411135

Carabias, J., Arriaga, V. et al. (2007). Las políticas públicas de la restauración ambiental en México: limitantes, avances, rezagos y retos, *Boletín de la Sociedad Botánica de México*, 80(80S): 85-100. http://dx.doi.org/10.17129/botsci.1759

Carabias, J., Arriaga, V. et al. (2008). Evolución de las políticas públicas de restauración ambiental. En: Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), *Capital natural de México - Vol. III Políticas públicas y perspectivas de sustentabilitdad*, pp.155-226. México: CONABIO.

Carabias J., Ruiz L., Rabasa, A. (2016). El marco legal de la restauración de ecosistemas forestales en México. En: *Experiencias Mexicanas en restauración de los ecosistemas,* pp. 49-76. Coordinado por Ceccon y Martínez. México: UNAM, UAEM, CONABIO.

Castañeda-Rincón, J. (2006). Las Áreas naturales protegidas de su origen precoz a su consolidación tardía. *Revista Electrónica de geografía y Ciencias Sociales*, Universidad de Barcelona. Vol. X, núm. 218 (13). http://www.ub.edu/geocrit/sn/sn-218-13.htm

Cedeño G., H. y Pérez R., D. (2007). *La legislación forestal y su efecto en la restauración en México*. México: Instituto Nacional de Ecología y Cambio Climático. http://www2.inecc.gob.mx/publicaciones2/libros/467/cedenoyperez.html

Comisión Nacional de Áreas Naturales Protegidas (2018). *100 años de conservación en México: Áreas Naturales Protegidas de México.* https://www.conanp.gob.mx/pdf/100A%C3%B1osConservaci%C3%B3n.pdf

_____ (2019). *Programa para la Protección y Restauración de Ecosistemas y Especies en Riesgo (PROREST) 2019.* https://www.gob.mx/conanp/acciones-y-programas/

programa-para-la-proteccion-y-restauracion-de-ecosistemas-y-especies-en-riesgo-prorest-2019

_____ (2020). *Tríptico PROCODES 2020*. https://www.conanp.gob.mx/procodes2020/TripticoPROCODES2020.pdf

Comisión Nacional del Agua (2021). *Mecanismos*.pdf. http://www.conagua.gob.mx/conagua07/contenido/documentos/mecanismos.pdf

Comisión Nacional Forestal (2001). *PROGRAMA NACIONAL FORESTAL 2001-2006*, Gobierno de los Estados Unidos Mexicanos Secretaría de Medio Ambiente y Recursos Naturales Comisión Nacional Forestal. http://www.conafor.gob.mx:8080/documentos/docs/4/308Plan%20Nacional%20Forestal%202001-2006.pdf

_____ (2011a). *Crece ProÁrbol 2011 en número de solicitudes*. http://www.conafor.gob.mx:8080/documentos/docs/7/1842Crece%20Pro%C3%81rbol%202011%20en%20n%C3%BAmero%20de%20solicitudes.pdf

_____ (2011b). *Lineamientos únicos 2011 final II_UAJ*. http://www.conafor.gob.mx:8080/documentos/docs/1/2189Lineamiento%20Programa%20Restauraci%c3%b3n%20de%20Microcuencas%20en%20Zonas%20Prioritarias.pdf

_____ (2012a). *Lineamientos 2012. Patzcuaro.docx*. http://www.conafor.gob.mx:8080/documentos/docs/1/1908Lineamientos%20de%20operaci%c3%b3n.pdf

_____ (2012b). *Lineamientos cuencas hidrográficas prioritarias*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/2bcb97aabe48cfe441a150885f1f8fb4.pdf

_____ (2012c). *Programa Forestal Federal Meseta Purepecha, Mlch*. http://www.conafor.gob.mx:8080/documentos/docs/1/2209Anexo%202%20Programa%20Meseta%20Pur%c3%a9pecha.pdf

_____ (2012d). *Lineamientos para Proyectos de Plantaciones Forestales.* https://www.conafor.gob.mx/apoyos//docs/adjuntos/2b49d02f2f89c736f0d011b2de5d2d87.pdf

_____ (2012e). *Mecanismo Operativo del Proyecto de Desarrollo Sustentable para las Comunidades Rurales e Indígenas del Noroeste Semiárido (PRODESNOS)*. http://www.conafor.gob.mx:8080/documentos/docs/1/2833Mecanismo%20Operativo%202012.pdf

_____ (2012f). Mecanismo Operativo del Proyecto de Desarrollo Comunitario Forestal de los Estados del Sur (DECOFOS). http://www.conafor.gob.mx:8080/documentos/docs/1/2745Mecanismo%20Operativo%202012.pdf

_____ (2012g). *Programa Nacional Forestal 2014-2018 en Plan Nacional de Desarrollo*. Comisión Nacional Forestal, Secretaría de Medio Ambiente y Recursos Naturales. http://www.conafor.gob.mx:8080/documentos/docs/4/5382Programa%20Nacional%20Forestal%202014-2018.pdf

_____ (2012h). F*omento a la Organización Social, Planeación y Desarrollo Regional Forestal (PROFOS)*. http://www.conafor.gob.mx:8080/documentos/docs/1/4088CNF-16%20PROFOS.pdf

_____ (2012i). *Convocatoria Cuencas Costeras del Estado de Jalisco*. http://www.conafor.gob.mx:8080/documentos/ver.aspx?articulo=2634&grupo=1

_____ (2012j). *Lineamientos Programa Especial Selva Lacandona*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/6a5109497784c43a26ef34cd58e082c0.pdf

_____ (2012k). *Programa Especial para la Restauración Conservación y Desarrollo Forestal Comunitario en Microcuencas Hidrográficas de la región de los Chimalapas*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/762716f87b2cb9c30c952cf4e4c5ae55.pdf

_____ (2012l). *Programa Especial para la Conservación, Restauración y el Manejo Sustentable de los Recursos Forestales de la Península de Yucatán*. https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2012/16

_____ (2012m). *Lineamientos para la Restauración Ecológica del área de protección de Flora y Fauna del Bosque de la Primavera*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/d6e53a935177d9087f59cbb7af441422.pdf

_____ (2012n). *Convocatoria del programa Tarahumara.docx*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/6a5109497784c43a26ef34cd58e082c0.pdf

_____ (2012o). C*onvocatoria 2012 Compensación Ambiental*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/a513178b799dc930cb0b5056ddd846a0.pdf

_____ (2012p). *Programa de Restauración de la Cuenca Río Verde Grande Ags*. https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2012/20

_____ (2012q). *Programa de Restauración de la Parte Alta de la Cuenca del Rio Nazas en el Estado de Durango*. https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2012/21

_____ (2013a). *Informe de Autoevaluación 2012.* https://www.gob.mx/cms/uploads/attachment/file/126558/Informes_2012_-_Informe_final_de_Autoevaluacion.pdf

_____ (2013b). *Mecanismo Operativo PRODESNOS 2013*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/4d420a139b4f5a2563884ad42a02cd95.pdf

_____ (2013c). *Lineamientos Complementarios CONAFOR*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/15a9907d0c21f244985c70a5549d7d64.pdf

_____ (2013d). *Lineamientos de Compensación Ambiental 2013 (final) 05-09-13.* https://conafor.gob.mx/apoyos//docs/adjuntos/ab700c9b4a9dac36e09c010c624493c4.pdf

_____ (2013e). *Mecanismo Operativo DECOFOS 2013*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/b03b1f7ba299090c9b96458f1442da6e.pdf

_____ (2013f). *Lineamiento de operación para el programa especial para la conservación, restauración y el manejo sustentable de los recursos forestales de la Península de Yucatán (PEPY). 3.* https://www.conafor.gob.mx/apoyos//docs/adjuntos/5441dcb7298470d2e884c5308ee8996d.pdf

_____ (2016). *Prensa, Restauran 8 mil 620 hectáreas de la Cuenca Alta del Río Nazas en Durango.* https://www.gob.mx/conafor/prensa/restauran-8-mil-620-hectareas-de-la-cuenca-alta-del-rio-nazas-en-durango

_____ (2014a). *Estrategia Nacional para REDD+ (ENA-REDD+).* http://www.conafor.gob.mx:8080/documentos/docs/35/5559Elementos%20para%20el%20dise%C3%B1o%20de%20la%20Estrategia%20Nacional%20para%20REDD_.pdf

_____ (2014b). *Lineamientos de Operación del Proyecto DECOFOS 2014.* https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2014/43

_____ (2014c). *Lineamiento Programa Especial de Áreas de Acción Temprana REDD+.* https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2014/44

_____ (2014d). *Lineamiento de Operación del Programa de Fomento a la Organización Social, Planeación y Desarrollo Regional Forestal.* https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2014/45

_____ (2014e). *Apoyo Institucional en la implementación de Eventos y Proyectos de Capacitación, Educación, Transferencia de Tecnología y Cultura Forestal.* https://www.conafor.gob.mx/apoyos//docs/adjuntos/3cf6d68ca52d6cb447956413de318e7b.pdf

_____ (2014f). *Criterios de Operación del Programa Compensación Ambiental por CUST.* https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2014/47

_____ (2014g). *Lineamientos de apoyos Innovación y Transferencia de Tecnología.* https://www.conafor.gob.mx/apoyos/index.php/inicio/app_apoyos#/detalle/2014/48

_____ (2014h). *Lineamiento del Fondo Patrimonial Biodiversidad*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/6167120e7ab3670d1d65fd00d8c1919b.pdf

_____ (2016). *Mecanismos específicos para la prevención, control y combate de contingencias ambientales causadas por plagas y enfermedades forestales e incendios forestales.* http://sivicoff.cnf.gob.mx/ContenidoPublico/mnuLDerecho/03TratamientoFitosanitarioForestal/02PlagasForestales/Mecanismos%20espec%C3%ADficos%20para%20la%20prevenci%C3%B3n,%20control%20y%20combate.pdf

_____ (2017a). *Acciones tempranas REDD+ Una acción temprana REDD+ (ATREDD+) es un esfuerzo articulado institucionalmente a nivel subnacional (regional y local).* https://www.gob.mx/conafor/documentos/acciones-tempranas-redd

_____ (2017b). *Criterios de Operación del Programa Compensación Ambiental por cambio de uso de suelo en terrenos forestales 2018.* https://www.conafor.gob.mx/apoyos//docs/adjuntos/16ba5e021a82896eb5947c836cedb67e.pdf

_____ (2017c). *Lineamientos para realizar Auditorías Técnicas Preventivas. Comisión Nacional Forestal (CONAFOR). Zapopán, Jalisco, México.* https://www.gob.mx/cms/uploads/attachment/file/301727/Lineamiento_para_realizar_Auditorias_Tecnicas_Preventivas.pdf

_____ (2017d). *Criterios para la producción de planta del Programa Nacional Forestal*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/6843f0c2ad5f90c4bb7ef4b1ed3b2c05.pdf

_____ (2018). *Libro Blanco, Programa Nacional Forestal PRONAFOR*. http://www.conafor.gob.mx:8080/documentos/docs/1/7625Programa%20Nacional%20Forestal%202014-2018(PRONAFOR).pdf

_____ (2019a). *Mecanismos específicos para contingencias ambientales e incendios forestales 2019*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/dbcbfe634347e29de35663e8ece89549.pdf

_____ (2019b). *Lineamiento del Fondo Patrimonial Biodiversidad*. https://www.conafor.gob.mx/apoyos//docs/adjuntos/2e5e0ebe9f321db1752cf8588b6e92db.pdf

_____ (2019c). *Criterios de Producción de Planta de la PRONAFOR 2018.* https://www.conafor.gob.mx/apoyos//docs/adjuntos/110cf5e9e60d88f66943dabbacbf01fa.pdf

_____ (2020) *Innovación Forestal, Recuperación de Superficie Forestal Mediante Reforestación.* http://www.conafor.gob.mx/innovacion_forestal/?p=1009

_____ (2020) *Protocolo de Áreas Elegibles 2020, Gerencia de reforestación y restauración de cuencas hidrográficas*. https://old-snigf.cnf.gob.mx/wp-content/

uploads/Indicadores%20MIR/2020/Protocolo_Areas_Elegibles_2020.pdf

_____ (2021). *Programa Estratégico Forestal para México 2025.INFORME FINAL Versión 2.1 del 18 de agosto de 2001.* http://www.conafor.gob.mx:8080/documentos/docs/4/307Programa%20Estrat%C3%A9gico%20Forestal%202025.pdf

_____ (2021). *Zonificación forestal, categoría II, Zonas de Producción. México.* https://idefor.cnf.gob.mx/layers/geonode:zonas_produccion_dissolve/pdf_metadata_layer

Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (2012). *Estrategia Mexicana para la Conservación Vegetal 2012-2030*. Ciudad de México, México: Editorial impresora apolo, S.A. de C.V. https://www.concyteq.edu.mx/amjb/repositorio/documentos/polit_doc/nacionales/EstrategiaMexConservacionVegetal.pdf

_____ (2018). *Prensa. Guía para la restauración de los ecosistemas terrestres Mexicanos.* https://www.gob.mx/conabio/prensa/guia-para-la-restauracion-de-los-ecosistemas-terrestres-mexicanos?idiom=es#:~:text=En%202015%2C%20dio%20inicio%20un,los%20ambientes%20terrestres%20de%20M%C3%A9xico

_____ (2020). *Proyecto Corredor Biológico Mesoamericano-México.* https://www.biodiversidad.gob.mx/region/cbmm/proyectos-nacionales

_____ (2021). *Convenio de la Diversidad Biológica*. https://www.biodiversidad.gob.mx/planeta/internacional/cbd

Consejo Civil Mexicano de la Silvicultura Sostenible (2022). *Ley Forestal 1926.* https://www.ccmss.org.mx/acervo/ley-forestal-1926/#:~:text=La%20Ley%20Forestal%20de%201926,t%C3%A9cnico%20para%20alcanzar%20estos%20fines.

Consejo Nacional de Evaluación de la Política de Desarrollo Social (2019). *Ficha de monitoreo 2017-2018 del Programa de Empleo Temporal*. México: SEMARNAT.

Conservación Internacional (2020). *Trends. Earth.* http://trends.earth

Convención de Naciones Unidas de Lucha Contra la Desertificación (UNCCD) (1996). https://www.unccd.int/sites/default/files/relevant-links/2017-08/UNCCD_Convention_text_SPA.pdf

Convención Marco de las Naciones Unidas sobre el Cambio Climático (CMNUCC) (2022). https://unfccc.int/es/process-and-meetings/the-paris-agreement/el-acuerdo-de-paris

Convenio sobre la Diversidad Biológica (CDB) (2010). *Guía breve para la Meta 15 de las Metas de Aichi para la Diversidad Biológica.* https://www.cbd.int/doc/strategic-plan/targets/T15-quick-guide-es.pdf

_____ (2012). *Estrategia Mundial para la Conservación de las Especies Vegetales*. Richmond, UK Botanic Gardens Conservation International. https://www.plants2020.net/files/Plants2020/GSPCbrochure/gspc_spanish.pdf

Cuenta Pública hacienda Gobierno de México (2014). *Cuenta Pública 2014. Instituto de Ecología y Cambio climático*. https://www.cuentapublica.hacienda.gob.mx/work/models/CP/2014/tomo/VII/RJJ/RJJ.01.INTRO.pdf

Cuenta Pública hacienda Gobierno de México (2018). *Comisión Nacional de las Zonas Áridas.* https://www.cuentapublica.hacienda.gob.mx/work/models/CP/2018/tomo/VII/Print.IZI.01.INTRO.pdf

Dave, R., Saint-Laurent, C., Moraes, M., Simonit, S., Raes, L., Karangwa, C. (2018). *El Barómetro de Progreso del Desafío de Bonn: Informe monográfico 2017*. Gland, Suiza: UICN. https://portals.iucn.org/library/node/47854

Dave, R., Saint-Laurent, C., Murray, L., Antunes Daldegan, G., Brouwer, R., de Mattos Scaramuzza, C.A., Raes, L., Simonit, S., Catapan, M., García C., G., Ndoli, A., Karangwa, C., Perera, N., Hingorani, S. and Pearson, T. (2019). *Second Bonn Challenge progress report. Application of the Barometer in 2018*. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2019.06.en

Decenio de Naciones Unidas sobre la Restauración (2022). *Sobre Sobre el Decenio de las Naciones Unidas. Decenio de la Naciones Unidas sobre la Restauración*. ONU Programa para el Medio Ambiente, Organización de las Naciones Unidas para la Alimentación y la Agricultura. https://www.decadeonrestoration.org/es/sobre-el-decenio-de-las-naciones-unidas

Delgado, E. y Lloret, M. (2009). Planificación del Desarrollo Territorial y Local en Cuba; Aspectos conceptuales, metodológicos y estratégicos. *Aportes*, Revista de la Facultad de Economía, BUAP, Año XIV, Número 41, mayo-agosto. Puebla, México.

Diario Oficial de la Federación (1926). *Secretaría de Agricultura y Fomento. Ley Forestal.* http://www.dof.gob.mx/nota_to_imagen_fs.php?cod_diario=190041&pagina=1&seccion=0

_____ (1986). *Secretaría de Agricultura y Recursos Hidráulicos. Ley Forestal.* http://dof.gob.mx/nota_detalle.php?codigo=4795460&fecha=30/05/1986

_____ (1988). *Ley General de Equilibrio Ecológico y Protección Ambiental 1998.* https://dof.gob.mx/nota_detalle.php?codigo=4718573&fecha=28/01/1988#gsc.tab=0

_____ (1992). *Ley Forestal*. http://dof.gob.mx/nota_detalle.php?codigo=4705370&fecha=22/12/1992

_____ (1997). *DECRETO por el que se reforma la Ley Forestal*. http://www.dof.gob.mx/nota_detalle.php?codigo=4880102&fecha=20/05/1997

_____ (2001). *DECRETO por el que se crea la Comisión Nacional Forestal*.

_____ (2003). *DECRETO por el que se expide la Ley General de Desarrollo Forestal Sustentable.* https://www.dof.gob.mx/nota_detalle.php?codigo=705172&fecha=25/02/2003#:~:text=La%20presente%20Ley%20es%20reglamentaria,%2C%20restauraci%C3%B3n%2C%20producci%C3%B3n%2C%20ordenaci%C3%B3n%2C&gsc.tab=0

_____ (2018). *Ley General de desarrollo Forestal Sustentable.* https://dof.gob.mx/nota_detalle.php?codigo=5525247&fecha=05/06/2018#gsc.tab=0

_____ (2020a). *Secretaría del Bienestar, lunes 28 de diciembre de 2020. ACUERDO por el que se emiten las Reglas de Operación del Programa Sembrando Vida, para el ejercicio fiscal 2021.* https://www.gob.mx/cms/uploads/attachment/file/603289/ROPS_Sembrando_Vida_28dic2020.pdf

_____ (2020b). *REGLAS de Operación del Programa Apoyos para el Desarrollo Forestal Sustentable 2021.*

_____ (2021). *Ley General de Desarrollo Forestal Sustentable.* http://www.dof.gob.mx/nota_detalle.php?codigo=5616767&fecha=26/04/2021

_____ (2022). *REGLAS de Operación del Programa Apoyos para el Desarrollo Forestal Sustentable 2022.* https://www.dof.gob.mx/nota_detalle.php?codigo=5639498&fecha=28/12/2021#:~:text=El%20Programa%20Apoyos%20para%20el,%2C%20forestales%2C%20sociales%20y%20econ%C3%B3micos

Echeverría, C., Smith-Ramírez, C., Aronson, J., Barrera-Cataño, J.I. (2015). *Good news from Latin America and the Caribbean: national and international restoration networks are moving ahead.* Restor. Ecol. 23: 1-3. http://www.erecolombia.com/files/Echeverria_et_al-2015-Good_news.pdf

Foppen, R. P. B., Bouwma, I., Kalkhoven, J. T. R., Dirksen, J., and Opstal, S. (2000). *Corridors in the Pan-European Ecological Network, concepts and examples for terrestrial and freshwater vertebrates.* ECNC, Tilburg.

Freiberg, H. (2014). Suiza. El Desafío de Bonn. *Arborvitae*, edición 45, junio.

Gobierno de México (2022a). *Convocatoria proyecto RÍOS.* https://www.gob.mx/inecc/articulos/convocatoria-para-propuestas-para-financiar-subproyectos-para-la-restauracion-de-rios-para-la-adaptacion-al-cambio-climatico?idiom=es

_____ (2022b). *Convocatoria proyecto CONECTA*. https://www.gob.mx/inecc/es/articulos/convocatoria-conecta?idiom=es

González V., Carlos E. (2012). *III. La creación de la Comisión Nacional Forestal en La Comisión Nacional Forestal en la historia y el futuro de la política forestal de México*,. coordinador Gustavo A. Del Ángel-Mobarak. Primera edicción. https://www.conafor.gob.mx/biblioteca/documentos/Conafor_en_la_historia_y_futuro_de_Mexico.pdf

Guerrero, G. B. y Pereznegrón Pereznegrón, R. (2017). Evolución, prospectiva y administración de las zonas áridas en México (CONAZA). En: *Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*, Serie Memoria y Prospectiva de las Secretarías de Estado, pp. 445-473. Ciudad de México, México: Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. https://archivos.juridicas.unam.mx/www/bjv/libros/11/5278/21.PDF

Gutiérrez, Y. (2012). Proárbol, un programa que da vida a los ecosistemas. En: *Mi Ambiente*. https://www.miambiente.com.mx/comunitarias/proarbol-un-programa-que-da-vida-a-los-ecosistemas/

Gurrutxaga, M. (2003). *Índices de fragmentación y conectividad para el indicador de biodiversidad y paisaje de la CAPV*. Gobierno Vasco. Comunidad Autónoma del País Vasco

Initiative 20X20 (2021). *Comunicado Ministerial de la Iniciativa 20x20 del 2021*. https://initiative20x20.org/es/news/comunicado-ministerial-de-la-iniciativa-20x20-del-2021

Institute European Environmental Policy (2020). *Climate and soil policy brief - Better integrating soil into EU climate* policy. https://ieep.eu/uploads/articles/attachments/437a17b8-f8a4-478d-ab7f-4a74e2e-60ced/IEEP%20(2020)%20Climate%20and%20soil%20policy%20brief%20-%20Better%20integrating%20soil%20into%20EU%20climate%20policy.pdf?v=63771126961

Instituto Nacional de Ecología y Cambio Climático (2007). *La legislación forestal y su efecto en la restauración en México*, Heidi Cedeño Gilardi y Diego R. Pérez Salicrup. México: Centro de Investigaciones en Ecosistemas, Universidad Nacional Autónoma de México. http://www2.inecc.gob.mx/publicaciones2/libros/467/cedenoyperez.html

Instituto Nacional de Estadística y Geografía (2018). *División política municipal 2018*. México. Instituto Nacional de Estadística y Geografía. http://www.conabio.gob.mx/informacion/metadata/gis/muni_2018gw.

xml?_httpcache%20=%20yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent%20=%20no

Instituto Nacional de Geografía y Estadística (INEGI) (2020). *Sistema de Cuentas Nacionales de México. Cuentas Económicas y Ecológicas de México. Gastos en protección ambiental del sector público, por actividad ambiental*. Año base 2013. https://www.inegi.org.mx/programas/ee/2013/default.html#Tabulados

International Resource Panel (IRP) (2019). *Land Restoration for Achieving the Sustainable Development Goals : An International Resource Panel Think* Piece. Herrick, J.E., Abrahamse, T., Abhilash, P.C., Ali, S.H., Alvarez-Torres, P., Barau, A.S., Branquinho, C., Chhatre, A., Chotte, J.L., Cowie, A.L., Davis, K.F., Edrisi, S.A., Fennessy, M.S., Fletcher, S., Flores-Díaz, A.C., Franco, I.B., Ganguli, A.C., Ifejika Speranza, C., Kamar, M.J., Kaudia, A.A., Kimiti, D.W., Luz, A.C., Matos, P., Metternicht, G., Neff, J., Nunes, A., Olaniyi, A.O., Pinho, P., Primmer, E., Quandt, A., Sarkar, P., Scherr, S.J., Singh, A., Sudoi, V., von Maltitz, G.P., Wertz, L., Zeleke, G. A think piece of the International Resource Panel. Nairobi, Kenya: United Nations Environment Programme.

LJF.MX. (2014). *Restauración de la Cuenca del Río Verde, Prioridad para el 2014*, Sociedad y Justicia. https://www.lja.mx/2014/01/restauracion-de-la-cuenca-rio-verde-prioridad-para-el-2014/

Limón-Aguirre, M. (2021). *La nueva ley de desarrollo forestal sustentable*. Centro de Estudios Jurídicos y Ambientales A.C. http://www.ceja.org.mx/articulo.php?id_rubrique=29&id_article=127

Mazón, M. y Gutiérrez, N. (2016) Pasado y presente de la restauración ecológica en el contexto venezolano. *Interciencia*, vol.41(7): pp. 454-469. https://www.redalyc.org/pdf/339/33946267003.pdf

Méndez-Toribio, M., Martínez-Garza, C., Ceccon, E. y Guariguata, M.R. (2018b). *La restauración de ecosistemas terrestres en México: Estado actual, necesidades y oportunidades*. Documentos Ocasionales 185. Bogor, Indonesia: CIFOR.

Mora, F. (2018). A spatial framework for detecting anthropogenic impacts on predator-prey interactions that sustain ecological integrity in Mexico. *Ecol Process*, 7(35). https://doi.org/10.1186/s13717-018-0146-4

Organización Internacional del Trabajo (OIT), Fondo Monetario Internacional (FMI), Organización para la Cooperación y el Desarrollo Económico (OCDE), Oficina Estadística de las Comunidades Europeas, Organización de las Naciones Unidas y Banco Mundial (2006). *Manual del índice de precios al consumidor: Teoría y práctica*. Edición en Español, Washington: Fondo Monetario Internacional 2006.

Observatorio 10 (2022). Organización de las Naciones Unidas (ONU), Comisión Económica para América Latina y el Caribe (CEPAL). *Convención Internacional de Lucha contra la Desertificación en los países Afectados por Sequía Grave o Desertificación en Particular en África (CNULD)*. Observatorio del principio 10 en América Latina y el Caribe. https://observatoriop10.cepal.org/es/tratados/convencion-internacional-lucha-la-desertificacion-paises-afectados-sequia-grave-o

Organización de las Naciones Unidas para la Agricultura y Alimentación (FAO) (2021). *Base de datos FAOLEX, Ley de Aguas Nacionales*. https://www.fao.org/faolex/results/details/es/c/LEX-FAOC003015/

_____ (2021). *Ecosystem Restoration Playbook A practical guide to healing the planet, Developed for World Environment Day 2021 To kick off the United Nations Decade on Ecosystem Restoration (2021-2030).* https://unenvironment.widen.net/s/ffjvzcfldw/ecosystem-restoration-playbook

Programa de Naciones Unidas para el Medio Ambiente (PNUMA) (2022). *Nueva Década de la ONU para la Restauración de los Ecosistemas, una gran oportunidad para la seguridad alimentaria y la acción climática*. https://www.unep.org/es/noticias-y-reportajes/comunicado-de-prensa/nueva-decada-de-la-onu-para-la-restauracion-de-los

Salazar Mora, S.L., Tierra Tierra, N. P., y Salas Castelo, E. M. (2020). Diagnóstico situacional de la comunidad Capirona, parroquia Puerto Napo, cantón Tena, provincia de Napo, previo a la elaboración del inventario de atractivos turísticos. *Ciencia Digital*, 4(3).

Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (2013a). *Evaluación de Resultados del Programa de Sustentabilidad de los Recursos Naturales COMPONENTE COUSSA 2013 SAGARPA y Gobierno del Estado de Veracruz.* https://www.gob.mx/cms/uploads/attachment/file/273449/140702_Informe_final_COUSSA_2013.pdf

_____ (2013b). *Evaluación Nacional del Funcionamiento y la Operación 2012, Programa de Sustentabilidad de los Recursos Naturales Componente COUSSA en Concurrencia de Recursos.* https://www.agricultura.gob.mx/sites/default/files/sagarpa/document/2018/11/14/1530/14112018-programa-de-sustentabilidad-de-los-recursos-naturales-coussa-int.pdf

Secretaría de Medio Ambiente y Recursos Naturales (2010). *Estrategia Nacional de Manejo Sustentable de Tierra, Secretaría de Medio Ambiente y Recursos Naturales (Semarnat)*. Subsecretaría de Fomento y Normatividad Ambiental. Sistema Nacional de Lucha contra la Desertificación y la Degradación de los Recursos Naturales (Sinades).

_____ (2013). *Compendio de Estadísticas Ambientales 2013*. https://apps1.semarnat.gob.mx:8443/dgeia/compendio_2013/mce_index.html

_____ (2018). *Semarnat. Informe de la Situación del Medio Ambiente en México*, edición 2018. CdMX, México: PNUD.

_____ (2020). *Avanza Semarnat en Programa de Restauración Ecológica para la región de Tula-Atitalaquia-Apaxco.* https://www.gob.mx/semarnat/prensa/avanza-semarnat-en-programa-de-restauracion-ecologica-para-la-region-de-tula-atitalaquia-apaxcostauracion-ecologica-para-la-region-de-tula-atitalaquia-apaxco

Secretaría de Medio Ambiente y Recursos Naturales, CONAFOR – Gerencia de Reforestación y Restauración de Cuencas Hidrográficas (2020). *Protocolo de Áreas Elegibles 2020*. https://old-snigf.cnf.gob.mx/wp-content/uploads/Indicadores%20MIR/2020/Protocolo_Areas_Elegibles_2020.pdf

Secretaría de Bienestar (2020). *Sembrando Vida es el programa agroforestal productivo más grande del mundo y el más importante generador de empleos del país*. https://www.gob.mx/bienestar/prensa/sembrando-vida-es-el-programa-agroforestal-productivo-mas-grande-del-mundo-y-el-mas-importante-generador-de-empleos-en-el-pais#:~:text=A%20dos%20a%C3%B1os%20del%20anuncio%20de%20su%20creaci%C3%B3n%2C%20el%20programa,de%20empleos%20en%20el%20pa%C3%ADs

Segura-Warnholtz, G. (2014). Quince años de políticas públicas para la acción colectiva en comunidades forestales. *Revista Mexicana de Sociología*, 76(5): 105-135. https://www.researchgate.net/publication/357456418_Medio_siglo_de_evolucion_en_el_manejo_y_conservacion_de_los_bosques_comunitarios_en_el_noroeste_de_Mexico

Unión Internacional para la Conservación de la Naturaleza (UICN) (2018). *Serie Notas de Política: Objetivos de Desarrollo Sostenible – 1. Integrar las Metas de Biodiversidad de Aichi en los Objetivos de Desarrollo Sostenible*.

_____ (2021). *Bosques, El Desafío de Bonn*. https://www.iucn.org/es/tema/bosques/el-desafio-de-bonn

_____ (2022). *El Barómetro de la Restauración: una guía para los gobiernos*. Gland, Suiza: UICN. https://restorationbarometer.org/knowledge-hub/restoration-barometer-a-guide-for-governments/

_____ (2022b). *El Desafío de Bonn*. https://www.iucn.org/es/tema/bosques/el-desafio-de-bonn

United Nations Climate Change (2015). *Declaración de Nueva York sobre los Bosques - Reducir a la mitad la pérdida anual de bosques naturales para 2020 y alcanzar la deforestación cero en 2030.* https://unfccc.int/es/news/declaracion-de-nueva-york-sobre-los-bosques

_____ (2022). *Qué es la Convención Marco de las Naciones Unidas sobre el Cambio Climático*. https://unfccc.int/es/process-and-meetings/the-convention/que-es-la-convencion-marco-de-las-naciones-unidas-sobre-el-cambio-climaticow

Universidad Autónoma de Coahuila (2016). *La Ley General de Aguas, antecedentes y proceso legislativo en 2015*. [1] http://www.cienciacierta.uadec.mx/2016/06/20/la-ley-general-de-aguas-antecedentes-y-proceso-legislativo-en-2015-1/#:~:text=%5B5%5D%20Habiendo%20sido%20aprobada%20la,presidencia%20de%20Emilio%20Portes%20Gil

Vega Mora, L. (2002). Hacia un diagnóstico territorial bajo enfoque sistémico. *Innovar, 12(20): 45-54*. https://revistas.unal.edu.co/index.php/innovar/article/view/24277

World Research Institute México (2020). *La restauración: actividad clave para limitar el calentamiento global.* https://wrimexico.org/bloga/la-restauraci%C3%B3n-actividad-clave-para-limitar-el-calentamiento-global

_____ (2021). *Iniciativa 20x20: Países latinoamericanos se unen para restaurar el clima, los sistemas alimentarios y la biodiversidad*. https://initiative20x20.org/es/news/iniciativa-20x20-los-paises-latinoamericanos-se-unen-para-restaurar-el-clima-los-sistemas

Annexes

Annex I

Table 1 Restoration actions and regulatory instruments developed in Mexico from 1926 to 2010

YEAR	INSTRUMENT AND SHARES
1926	The Forest Law was decreed during the government of Plutarco Elías Calles (1924-1928) (Diario Oficial, 1926). Since then, the relevance of forests has been recognized as a way of controlling soil erosion and protecting hydrological basins and water catchments.
1934-1940	During the government of President Lázaro Cárdenas, the Forest Department of Hunting and Fishing promoted the reforestation of green areas in Mexico City and rural areas under the figure of Repopulation Forest Zones (Carabias, 2016). Two million trees were planted in the Valley of Mexico and four million in the rest of the country, for which he used the army and the creation of the national, state, and municipal nurseries (Castaneda, 2006). The Forest Law, valid for 4 years and 11 months, is in charge of the Ministry of Agriculture and Development.
1940-1960	The soil conservation programs established in the irrigation districts are developed (Carabias, 2016). In 1948, the Forest Law was published, valid for 12 years, in charge of the Ministry of Agriculture and Development. In the following two decades, the emphasis was on soil and water conservation works, and reforestation concentrated on fruit orchards and plantations with timber species of commercial interest. (Cervantes V, 2008)
1960	The Forest Law was decreed with the primary objective of managing the silviculture industry at a national level by regulating conservation, use, and restoration of forests, as well as the transport and trade of forest products (CCMSS, 2022). This forest law was in charge of the Ministry of Agriculture and Livestock, valid for 26 years and 5 months.
1970	During the presidency of Gustavo Díaz Ordaz (1964-1970), agronomists achieved the application of soil conservation practices (Salicrup, 2007). The National Commission of Arid Zones was created as a response to seek the improvement of the living conditions of the population located in these zones, as well as to increase the rational use of the natural resources located there (Guerrero García, 2017)
1976-1982	During the administration of José López Portillo, afforestation and reforestation actions were carried out within the framework of COPLAMAR (General Coordination of the National Plan for Depressed Areas and Marginalized Groups). Fruit orchards and soil conservation works were established, accompanied by fruit trees and non-timber forest species. (Cervantes V, 2008)
1982	The Secretariat of Urban Development and Ecology (SEDUE) is created, in which the National System of Natural Protected Areas (SINPNA) was developed(González-Vicente, 2012)
1986	The Ministry of Agriculture and Hydraulic Resources (SARH) issued the Forest Law, and its validity was 6 years and 6 months (Diario Oficial de la Federación, 1986).
1988	The National Reforestation Program (PRONARE) was created under the responsibility of the Ministry of Agriculture, Livestock and Hydraulic Resources (SARH) (which never achieved the objectives set), and three years later, the Forest Solidarity Program was under the responsibility of the Secretariat of Social Development (SEDESOL) (Carabias J., 2007)
1991	The National Reforestation Program (PRONARE) was announced and officially created in 1992 (Limón-Aguirre, 2021)
1992	The Forest Law was published, which states, among other purposes, the following: I. Conserve, protect and restore forest resources and the biodiversity of their ecosystems; II. Protect the basins, riverbeds, and natural drainage systems, prevent and control soil erosion, and seek its restoration (Diario Oficial de la Federación, 1992). This law is in charge of the SARH, and its validity was 4 years and 5 months. The National Commission for the Knowledge and Use of Biodiversity (CONABIO) was created (Diario Oficial de la Federación, 1992), which promoted different projects on restoration issues.

1994	The efforts of the PRONARE and PSF programs were unified under an inter-ministerial agreement that included SEDESOL, the newly created Ministry of the Environment, Natural Resources and Fisheries (SEMARNAP), the Ministry of Public Education (SEP), the Ministry of Agriculture, Livestock and Rural Development (SAGAR) and SEDENA. The Executive Coordination of this program and the financial resources initially remained with SEDESOL until the end of 1997, when the Congress of the Union transferred PRONARE to SEMARNAP (Carabias J., 2007). It was then that reforestation was given a new approach incorporating environmental criteria. Restoration of degraded sites with species native to each region was prioritized and emphasized plant survival. In 1998, the first Ecological Restoration Zones were established in burned areas (Carabias, 2016). PRONARE functioned from 1997 to 2004, then transferred its activities to the Conservation and Restoration of Ecosystems Program (PROCOREF) (Gobierno de México, 2021). The gradual application of these instruments contributed to the fact that in 1995-2000 reforestation was carried out on 960,000 hectares, in which 1,670 million plants were planted (Cervantes V, 2008). The United Nations Convention to Combat Desertification was installed on June 17, 1994, in Paris, France. It was signed by the Government of Mexico on October 15, 1994, and ratified by the Chamber of Senators of the H. Congress of the Union on April 3, 1995, enforced on December 1996. (SEMARNAT, 2010)
1995	SEMARNAP created the General Directorate for Soil Restoration and Conservation in order to address the problem of deterioration of the resource, reduce degradation processes and gradually restore it (Cervantes V, 2008).
1996	SEMARNAP created the General Directorate for Soil Restoration and Conservation to address the problem of deterioration of the resource, reduce degradation processes and gradually restore it (Cervantes V, 2008).
1997	Forest Law was issued by SEMARNAP and was valid for 6 years (Diario Oficial de la Federación, 1997). The Ministry of Environment, Natural Resources, and Fisheries published in the Official Gazette of the Nation the guidelines for granting subsidies destined to promote silviculture development. The Forest Development Program (PRODEFOR) began its operation in the General Forest Directorate of SEMARNAP. From its creation in 1997 to 2001, PRODEFOR was operated by SEMARNAP (SEMARNAT, 2013).
1998	The Project for Conservation and Management of Forest Resources in Mexico (PROCYMAF) began. It was designed between 1995 and 1997 and operated from 1998 to 2012, with financing from the World Bank between 1998 and 2008. From 2004 it was called the Community Forest Development Program but kept the name PROCYMAF. It had three stages: between 1998 and 2004, it operated in Oaxaca and later in Guerrero and Michoacán; between 2004 and 2008, it was extended to Durango, Jalisco, and Quintana Roo; between 2008 and 2012, to Campeche, Chiapas, Chihuahua, State of Mexico, Puebla and Veracruz (Segura-Warnholtz, 2014).
2000	The National Commission for Natural Protected Areas (CONANP) was created as a decentralized body of what is now SEMARNAT (CONABIO, 2012). It has a subsidy program for restoration actions, the Conservation Program for Sustainable Development (PROCODES) (CONANP, 2018).
2001	The National Forest Commission (CONAFOR) was created, which aimed to develop, favor and promote productive, conservation, and restoration activities in silviculture (Diario Oficial de la Federación, 2001). In September of that year, PRODEFOR was transferred to CONAFOR, maintaining its own rules of operation until 2005 (Secretaría de Medio Ambiente y Recursos Naturales, 2013). The Strategic Forest Program for Mexico 2025 was presented, which described, for the first time in the history of our country, a diagnosis, objectives, strategies, and priority actions for the next 25 years (CONAFOR, 2001). This program includes different restoration actions.
2003	The General Law on Sustainable Forest Development was issued (Diario Oficial de la Federación, 2003). The Mexican Forest Fund (FFM) was created as an "instrument to promote the conservation, to increase, sustainable use and restoration of forest resources and their associated resources. The fund facilitates access to financial services in the market, promoting projects that contribute to the integration and competitiveness of the productive chain, developing collection and payment mechanisms for environmental goods and services". Through the FFM, CONAFOR has become the executing agency for most of the forest restoration policies in Mexico, mainly through its PROARBOL (2007-2012), PROMARNAT (2013-2017), Support Program for Sustainable Forest Development (2018 to date), supplemented by activities implemented by subnational governments and other federal institutions. The Environmental Compensation and Restoration Program was established and signed by PROFEPA and CONABIO with the main objective of carrying out actions to restore or recover the country's ecosystems and natural resources, which were damaged or deteriorated for various reasons (Cervantes V, 2008). The National Forest Plan 2001-2006 was published, which included sustainable forest management, plantations, and restoration within its priorities, objectives, and strategies (CONAFOR, 2001).
2004	The Mexican Network for Environmental Restoration (REPARA) was formed to strengthen and make efficient research activities, training of human resources, and environmental education on the recovery and restoration of biodiversity, ecosystem services, and soil's productive capacity. The economic item was increased to carry out forest restoration activities, with which projects of research centers and public and private organizations are supported. Until the beginning of 2007, these resources had supported around 60 restoration projects (Cervantes V, 2008).
2006	The concepts of PRODEFOR support were incorporated, together with those of commercial forest plantations, soil conservation, and environmental services, into the operating rules of CONAFOR's silviculture development programs, known as Single Rules, which as of 2007, were constituted in the ProÁrbol Operating Rules (SEMARNAT, 2013).
2007	In 2007, ProÁrbol was announced as a program that integrates all aspects of conservation, effective promotion, and forest restoration. In the context of programs to improve plant cover and soil restoration and conservation, the proposed goal for the six-year period 2006-2012 was the reforestation of 2.4 billion hectares. On the other hand, SAGARPA (2006-2012) included the Program for Sustainable Use of Natural Resources for Primary Production in its operating rules. The variety of activities that are considered in it can set the guidelines to revitalize the programs of productive reconversion and fire control in lands with agricultural use (Cervantes V, 2008).
2009	The Program for the Restoration of Priority Basins emerged during this year as a new strategy to achieve a transition - from the traditional reforestation scheme of limited efficiency and high dispersion - to the intensive reforestation scheme in priority basins (CONAFOR, 2012). The program included the micro-basins of Pátzcuaro - Zirahuén, Chichinautzin, Izta -Popo, Nevado de Toluca, Pico de Orizaba, Cofre de Perote, and Lerma Chapala, and the Federal Forest Program of the Purepecha Plateau.
2010	The construction of the REDD+ strategy began to be prepared (CONAFOR, 2014)

Source: Own elaboration.

Annex II

Meetings with actors involved in consulting to learn about different aspects of restoration in Mexico:

The different actors related to restoration and different actions that are carried out in this topic in Mexico were identified..

- SEMARNAT
- CONAFOR
- FARMING
- CONAZA
- CONANP
- CONABIO
- AMERE (Mexican Alliance for the Restoration of Ecosystems)

SEMARNAT

Gertrudis Cleotilde Arellano Molina
Meeting date: 01.10. 2022
Meeting date: 01.24. 2022
Meeting date: 01.24. 2022

CONAFOR

An attempt was made to establish contact with the Reforestation and Hydrographic Basin Restoration management of the National Forest Commission, unfortunately this was not possible.

FARMING

Veronica Bunge Vivier
Meeting date: 01.07.2022

CONAZA

Héctor Manuel Arias
Meeting date: 01.11.2022

CONANP

Ignacio March Mifsut
Meeting date: 12.15.2021

CONABIO

Volke Tobón
Meeting date: 01.06.2022

AMERE

José Iván Zuñiga (WRI)
Meeting date: 12.10.2021

Annex III

Programs, components, projects, support and criteria managed by CONAFOR from 2011 to 2020

2011

ProÁrbol

It was a comprehensive program of the Federal Government whose objective was to promote sustainable silviculture development, which in turn allows the strengthening of social organization and contributes to reducing poverty and marginalization rates in the areas. As in 2010, the 2011 ProÁrbol Operation Rules maintained the criterion of targeting support in priority areas (CONAFOR, 2011a).

Within the Operating Rules (RO), published in 2010 (*Diario Oficial de la Federación*, 2010) it is mentioned that these are intended to:

a) Promote the production and productivity of forest resources, their conservation, protection, and restoration, as well as raise the level of competitiveness of the sector to help improve the quality of life of Mexicans.

b) Generate development and economic expansion based on the valuation, conservation, and sustainable use of the resources of forests, jungles, and the vegetation of arid zones.

c) They will contribute to mitigate the poverty indexes and marginalization in forest areas through the induction of adequate management and use of their natural resources.

d) Develop actions to comprehensively promote silviculture projects that enhance the capacity of support through financing, as well as general risk management mechanisms that encourage the participation of beneficiaries, financial intermediaries, and other interested parties in the promotion of silviculture investment projects.

e) Comply with the powers granted to CONAFOR by the General Law on Sustainable Forest Development and its Regulations, the Institutional Silviculture Program 2007-2012, and the Strategic Forest Program for Mexico 2025, as well as the other applicable regulatory provisions.

The 2011 ProÁrbol managed two categories: Forest Development and Conservation and Restoration, with their respective subcategories.

Special Program for the Restoration of Micro-basins Priority Zones

This program was created in 2011. It included the areas of Nevado de Toluca (State of Mexico), Lerma Chapala (Michoacán and Jalisco), Chichinautzin (Morelos, Federal District and the State of Mexico), Cofre de Perote (Puebla and Veracruz), Izta-Popo (Puebla, state of Mexico and Morelos) and Pico de Orizaba (Veracruz).

The objective was to mitigate the effects of climate change through plant cover recovery, soil erosion, flood prevention, and siltation of dams, rivers, canals, and other bodies of water. Also, by promoting infiltration and improvement in the quality and production of water and capture of carbon dioxide (CO_2); by carrying out soil restoration actions, reforestation, and other activities necessary for the restoration of ecosystems, thereby reducing the maintenance cost of hydraulic works and extending their useful life. This program contributes to the generation of jobs and income in rural communities, contributes to the diversification of productive activities; and to the production of environmental services (CONAFOR, 2011b).

2012

ProÁrbol

ProÁrbol was re-implemented with the same objectives and operating rules (Diario Oficial de la Federación, 2011) and the same categories handled for 2011.

Special Program for Micro-basins in Priority Areas

The program for micro-Basins in priority areas continued, maintaining the same objectives and activities.

Special Program Pátzcuaro and Zirahuén

The purpose of this program is to restore degraded areas of the Lakes of Pátzcuaro and Zirahuén basins in the State of Michoacán, mitigate the effects of climate change, recover tree cover, prevent soil erosion, floods, silt from dams, rivers, channels, and other bodies of water, promoting infiltration and improvement in the quality and production of water, and capture of carbon dioxide. This is done by carrying out soil restoration actions, reforestation and other activities necessary for the restoration of ecosystems, thereby reducing the maintenance cost of hydraulic works and lengthening their useful life; as well as providing employment and income to rural communities and contributing to the diversification of productive activities; and to the production of environmental services (CONAFOR, 2012a).

Cutzamala Special Program

The system comprises seven dams distributed in the state of Michoacán and the State of Mexico, being the hydraulic mechanism for the storage, conduction, and purification of fresh water for the population of Mexico City and the State of Mexico. The basin presents the problem of a decrease in vegetation cover, which increases soil erosion, deforestation, and soil dragging, causing silting of the reservoirs, and affecting their useful life. Therefore, actions for the protection, conservation, and restoration of forest soils were considered and integrated into the management of natural resources, especially vegetation, soil, and water. This contributes to the global objective of maintaining and improving the sustainability of said system (CONAFOR, 2012b).

Programa Forestal Federal Meseta Purépecha

The general objective of the program is to reduce the processes of deterioration of forest resources of the priority micro-basins located in the Meseta Purépecha Region in the State of Michoacán. This objective is to be achieved through restoration actions for the recovery of forest cover, forest cultivation, promoting and improving organizational and management capacities for community management of forest resources, and generating employment options for the inhabitants of this region (CONAFOR, 2012c).

State Support Program for Commercial Forest Plantation Projects

Created according to the Institutional Program of the National Forest Commission 2007-2012, and fulfilling objective 2, of establishing the need to raise the levels of production, productivity, and competitiveness of the silviculture sector. This will be achieved by increasing timber and non-timber forest production from commercial forest plantations.

The program managed support for establishing and initial maintenance of commercial forest plantations for timber and cellulose purposes. It also managed the support to cover the costs of the corresponding technical assistance; and support for advanced maintenance of established plantations, in which at least half of the commercial shift has already elapsed, as well as for the payment of technical assistance (CONAFOR, 2012d).

Sustainable Development Project for Rural and Indigenous Communities of the Semi-arid Northwest (PRODESNOS)

The objective of this program was to contribute reducing poverty and marginalization levels affecting the rural forest communities of the poorest municipalities in the states of Baja California, Chihuahua, Coahuila, and Sonora. It was done through the development of capacities to promote local processes of social and economic development, increasing their productive and employment opportunities, increasing their income, and at the same time, improving the sustainability of its natural resources (CONAFOR, 2012e).

Silviculture Community Development Project of the Southern States (DECOFOS)

The project was proposed to help improve the living conditions of the inhabitants of forest areas in poverty and extreme poverty through the development of sustainable, productive activities that help and promote the reduction of the effects of climate change and its negative impacts (CONAFOR, 2012f). It focused on 74 municipalities in Campeche, Chiapas, and Oaxaca.

Support to promote Local Payment Mechanisms for Environmental Services through concurrent funds

The objective of the concurrent funds was to combine the financial and human resources of the National Forest Commission and the interested parties to encourage the creation and strengthening of local payment mechanisms for environmental services. Promoting the participation of institutions of the three levels of government, organizations of the private sector or civil society, and, in general, of any person, natural or moral. This contribution of resources will be used to grant payments for the implementation of activities and, where appropriate, for the support of technical assistance, to the providers of environmental services to ensure or improve the provision of environmental services. (CONAFOR, 2012g).

Support for special forest conservation and restoration projects

These supports were raised with five objectives (CONAFOR, 2012g):

I. Implement actions and activities to conserve and restore ecosystems and forest species through special projects.

II. Comply with the powers granted to the National Forest Commission by the General Law on Sustainable Forest Development and its Regulations, the Institutional Silviculture Program 2007-2012, and the Strategic Forest Program 2025, as well as other applicable regulatory provisions.

III. Operate the projects regardless of the nature and source of the resources, whether chapters 2000, 3000, 4000, and 6000 of the federal public administration expenditure classifiers.

IV. Complement the programs that operate under the Operation Rules, to which, by general design, it is impossible to focus resources and activities, integrating the particularities of conservation and restoration of the species and work areas and the interested party in its realization.

V. Cooperate with other public and private entities interested in the Conservation and Restoration of forest ecosystems with resources, materials, study initiatives, and tools for forest conservation and restoration.

Program for the Promotion of Social Organization Planning and Regional Forest Development PROFOS

Generated to coordinate the operation, allocation and execution of federal support granted by CONAFOR, aimed at promoting silviculture development through the strengthening of social organization, planning and execution of projects of regional, state or national scope (CONAFOR, 2012h).

Special Program for Coastal Basins in the State of Jalisco

The program's general objective was to address the decrease in the forest area of the Coastal Basins region in the state of Jalisco, as well as address the degradation of forests and jungles, reverse the trend of change in forest land use and with this contribute to improve the living conditions of those who inhabit the region, promoting the articulation of the actions of the National Forest Commission, with those of other institutions, including public administration agencies, that promote Sustainable Rural Development (CONAFOR, 2012i).

It managed the following specific objectives:

- Promote, support and guide efforts aimed at conserving, sustainably exploiting, and restoring the forest ecosystems of the Coastal Basins region in the state of Jalisco, thereby seeking to improve the social well-being of its inhabitants.
- Promote the protection, restoration and conservation of the forest ecosystems of the Coastal Basins in the state of Jalisco.

- Promote the payment of environmental services, which encourage the preservation of natural resources in the Coastal Basins in the state of Jalisco.
- Promote strengthening local organizational and management capacities for the management, conservation and restoration of natural resources.
- Promote development schemes through the technical improvement of silviculture use.
- Align the different instruments of the National Forest Commission, so that they create greater synergy between them to impact deforestation and degradation.

Special Program for the Conservation, Restoration, and Sustainable Use of the Lacandona Jungle

The general objective of the program was focused on addressing the problem of diminishing forest areas in the Lacandona Jungle, halting the process of deterioration of forest vegetation in the areas of influence of the Lacandona Jungle, and reversing the trend of change in land use. Silviculture and the subsequent loss of forest vegetation due to development of economic activities in the region (CONAFOR, 2012j).

The different support concepts proposed are:

- Promote, support, and guide efforts aimed at conserving, sustainably exploiting, and restoring the region's ecosystems, seeking to improve social welfare in the Lacandona jungle region.
- Promote the protection, restoration, and conservation of the ecosystem of the Lacandona forest, through actions to induce natural regeneration, reforestation, restoration of riverbanks, and activities focused on forest protection.
- Promote the payment for environmental services, which encourage the preservation of the Lacandona jungle region.
- Promote productive diversification through managing projects and sustainable use of wildlife and non-timber forest products.
- Promote the strengthening of local organizations and management capacities for managing, conserving, and restoring natural resources.
- Align the different instruments of the National Forest Commission so that they create greater synergy between them to impact deforestation and degradation.

Special Program for Chimalapas Community Silviculture Restoration, Conservation, and Development

This program aimed to reduce deterioration processes and promote the protection of forest resources in the Chimalapas region in the states of Oaxaca and Chiapas. It seeks to improve social welfare in the region through restoration actions for the recovery of forest cover, forest cultivation, and the improvement of organizational and management capacities for community management of forest resources. (CONAFOR, 2012k).

Special Program for the Conservation, Restoration, and Sustainable Management of Forest Resources of the Yucatan Peninsula

The program was proposed to generate support to address the problem of decreasing forest areas, stop the process of deterioration of forest vegetation and reverse the trend of change in forest land use and the consequent loss of forest vegetation in the region of the Yucatan Peninsula. It promotes the articulation of CONAFOR's actions with those of other institutions, including public administration agencies, that promote Sustainable Rural Development (CONAFOR, 2012l).

Program for the Ecological Restoration of the Flora and Fauna Protection Area "Bosque la Primavera"

The program was designed to restore degraded forest ecosystems to compensate for the loss of vegetation and environmental services affected by ecological imbalances or processes of degradation and desertification in forest lands. It conducts soil restoration activities, reforestation, and other activities necessary to restore deteriorated forest ecosystems and promote ecological succession, its persistence, and evolution (CONAFOR, 2012m).

Restoration, Protection, and Development Program for the Tarahumara area in the State of Chihuahua

The program was proposed to support the implementation of forest restoration, protection, and development activities through the concepts of soil restoration works and practices, transplantation of pine forest off shoots, opening fire breaks, and pre-thinning in the municipalities. That includes the Tarahumara area in the State of Chihuahua (CONAFOR, 2012n).

Environmental Compensation for Land Use Change in Forest Land

The program's purpose was to carry out actions of soil restoration, reforestation, and maintenance of deteriorated forest ecosystems, so that, once their restoration is achieved, the environmental services they used to provide may be compensated. It was handled as applicable throughout the Mexican Republic except the states of Chiapas, Guanajuato, Veracruz, and the Federal District (CONAFOR, 2012o).

Restoration Program for the Río Verde Grande Basin in the State of Aguascalientes

The program's objective was to generate actions for conserving and restoring the degraded forest areas of the Río Verde Grande Basin in the State of Aguascalientes. This was to be done through the comprehensive management of basins with activities of soil restoration, forest protection, and surveillance, allowing reconversion production and efficient management of natural resources (CONAFOR, 2012p).

Restoration Program for the Upper Nazas River Basin in the State of Durango

The program sought to generate actions for the conservation and restoration of degraded forest areas in the upper part of the Nazas River Basin in the State of Durango through comprehensive basins management with soil restoration, reforestation, maintenance, and protection activities that allow productive reconversion and efficient management of natural resources (CONAFOR, 2012q).

2013

Programa Nacional Forestal PRONAFOR

PRONAFOR was designed to promote the sustainable use of the country's forest resources, reactivate the economy of the silviculture sector and improve the quality of life of the inhabitants of forest areas; as well as maintain and increase the provision of environmental goods and services to society and reduce carbon emissions generated by deforestation and forest degradation (CONAFOR, 2013). The program handles four components, each with a specific objective (*Diario Oficial de la Federación*, 2013).

COMPONENT I. SILVICULTURE DEVELOPMENT

Objective: Promote the use of forest resources and their associates, considering the principles of sustainable forest management and thereby contribute to maintaining and increasing the provision of environmental goods and services, as well as improving the quality of life of the owners and possessors of forest resources, through the granting of support for the preparation of studies for the incorporation of forest area into sustainable forest management schemes, for the execution of forest cultivation actions that are established in the studies and programs of property management for the use of timber, non-timber and wildlife resources. Strengthens infrastructure and equipment for the production of forest raw materials and support for forest certification processes.

COMPONENT II. COMMERCIAL FOREST PLANTATIONS

Objective: Promote the establishment of Commercial Forest Plantations to help increase forest production in the country by granting support for the establishment and initial maintenance and technical assistance.

COMPONENT III. CONSERVATION AND RESTORATION

Objective: Support the execution of actions and projects to recover forest cover and conserve and restore soils located in basins with forest lands and forests with deterioration processes. In order to help reduce these conditions, restore their structure and functions that make it possible to recover the capacity to provide environmental services or prevent the loss of soil or environmental services.

COMPONENT IV. ENVIRONMENTAL SERVICES

Objective: Support owners of forest land who voluntarily decide to participate in the program of payment for environmental services in order to incorporate good management practices to promote the conservation of ecosystems and encourage provision in the long term of environmental services, such as the capture of water, the maintenance of biodiversity and the sequestration and conservation of carbon, which benefits population centers or the development of productive activities.

Sustainable Development Project for Rural and Indigenous Communities of the Semi-arid Northwest (PRODESNOS)

It is a project that targets the poorest municipalities of Baja California, Chihuahua, Coahuila, and Sonora; Its objective is to contribute to reducing the levels of poverty and marginalization that affect rural forest communities; developing the capacities to promote local processes of social and economic development, increasing their productive and employment opportunities, increasing their income; and at the same time, improving the sustainability of its natural resources (CONAFOR, 2013b).

Forest Restoration Program in Priority Hydrographic Basins

Continuity is given to the program applied in 2011 and 2012, maintaining the same objective. This year, they incorporate Cutzamala-La Marquesa, Purépecha Plateau, Pátzcuaro-Zirahuén, Tarahumara Zone, Nazas River; Rio Verde Grande, and Chimalapas; a total of 12 basins, which were managed in 2012 in individual restoration programs.

The program had two support components (CONAFOR, 2013c):

1. Component A. **Community Forest Development**: Through this component, local development processes will be developed, strengthened, and consolidated in shared lands and forest communities in the priority regions mentioned before to improve traditional resource management under community forest development schemes.
2. Component B. **Forest Restoration**: This component will support the execution of actions and projects for the recovery of forest cover and the conservation and restoration of forest land, preferably forest and temporary forest with deterioration processes, to help reduce these conditions and restore its structure. These supports will have a duration of 5 years.

Operation Guidelines for Special Forest Conservation and Restoration Projects

This guideline establishes the rules and procedures of general application that must be observed in the selection, qualification, allocation, instrumentation, operation, monitoring, and evaluation of federal support by the National Forest Commission. Where appropriate, the participation of the beneficiaries, Governments of the Federal and municipal Entities was required. Their purpose is to regulate the operation of Special Forest Conservation and Restoration Projects (CONAFOR, 2013d). The specific objectives for special projects are:

I. Implement actions and activities to conserve and restore ecosystems and forest species through implementing Special Projects.

II. Comply with the powers granted to the National Forest Commission by the General Law on Sustainable Forest Development, its Regulations, the current Strategic Forest Program, and other applicable regulatory provisions.

III. Operate the projects regardless of the nature and source of the resources, whether chapters 2000, 3000, 4000, and 6000 of the classifiers by object of federal public administration spending.

IV. Complement the programs that operate under the Operating Rules and Guidelines, and due to their design, it is impossible to focus resources and activities, integrating the particularities of conservation and restoration of the species and work areas and the interested party in its fulfillment.

V. Cooperate with other public and private entities interested in the Conservation and Restoration of forest ecosystems with material resources and study initiatives and tools for forest conservation and restoration.

Program for Forest Restoration of Complementary Eligible Areas of PRONAFOR

The purpose of the program is to support the execution of actions for the recovery of forest cover, its maintenance, as well as the conservation and restoration of soils located in basins with forest land and preferably forest land in deterioration processes. It's final goal is to contribute to the reduction of environmental services, prevent the loss of soil or environmental services in degraded areas of the States of Puebla, Guanajuato, Tlaxcala, San Luis Potosí, Oaxaca, Jalisco, Durango, Nuevo León, Veracruz, Chiapas, Hidalgo, Chihuahua, Nayarit, Coahuila, Guerrero, Federal District and other states approved by the Technical Council (CONAFOR, 2013e).

It handled the following modalities:

Modality A.1. Comprehensive Restoration

Modality A.2. Complementary restoration

Modality A.3. Maintenance of restored areas

State Support Program for Commercial Forest Plantation Projects

It remains the same as implemented in 2012, with the same objectives.

Program to promote local payment mechanisms for environmental services through concurrent funds

Applied in 2012, it maintains the same objective set for its implementation in 2013.

Program for the Promotion of Social Organization, Planning, and Regional Forest Development

It continues what was proposed in the same program of 2012 and maintains the objectives set in the previous year.

Special Program for the Conservation, Restoration, and Sustainable Use of the Lacandona Jungle

It gives continuity to the 2012 program, maintaining the same objectives.

Environmental Compensation Program for Change in Land Use on Forest Land

It is a continuance of the program developed in 2012. It established the rules and procedures of the general application of the environmental compensation program for change in land use on forest land, which must be observed in the selection, allocation, operation, and monitoring of environmental compensation projects for change in land use on forest land (CONAFOR, 2013f).

The program aims to:

- Compensate for the loss of vegetation and environmental services affected by changes in land use on forest land through soil restoration activities, reforestation, and other activities necessary to rehabilitate deteriorated forest ecosystems and promote ecological succession, persistence, and evolution.

- Comply with the powers granted to CONAFOR by the General Law on Sustainable Forest Development and its Regulations, the Organic Statute, the Strategic Forest Program 2025, and other applicable legal provisions.

Silviculture Community Development Project of the Southern States DECOFOS

The 2012 program continues and aims to finance activities to promote and strengthen the target population's organizational capacity and social capital, as well as to generate planning tools for productive activities and management of economic resources. Such activities promote processes of local community development and contribute to climate change mitigation (CONAFOR, 2013g).

Special Program for the conservation, restoration, and sustainable management of forest resources in the Yucatan Peninsula (PEPY)

As in 2012, the program continues to address the problem of the decrease in the forest in Yucatan. It also manages the degradation of forest ecosystems, reversing the trend of changing the use of forest land, thereby contributing to improving the living conditions of the region's inhabitants. It supports forest communities in the sustainable management of forests, promoting the articulation of CONAFOR's actions with those of other institutions, including dependencies of the public administration in its different orders of government, that promote Sustainable Rural Development (CONAFOR, 2013h).

The specific objectives of the program are:

1. Promote, support, and join efforts under a logic of territoriality aimed at conserving, sustainably exploiting, and restoring forest ecosystems in the region of the Yucatan Peninsula, seeking to improve the social welfare of its inhabitants.
2. Integrate the different CONAFOR instruments, creating synergies to minimize deforestation and degradation.
3. Promote conservation, restoration, and management of the forest area in the Yucatan Peninsula.
4. Promote the strengthening of local capacities for organization and territorial management in owners and users of forest lands.
5. Develop, strengthen and consolidate local development processes with owners and possessors of forest land to improve the traditional management of resources under community silviculture development schemes.
6. Promote the payment for environmental services, which encourage the preservation of natural resources in the Yucatan Peninsula.
7. Promote development schemes through the technical improvement of forest use and good management practices.
8. Collaborate in the preparation and implementation of fire management plans.

Special Program for Coastal Basins in the State of Jalisco

It maintains the same objective as in 2012 and makes some modifications to its specific goals (CONAFOR, 2013b):

1. Promote, support, and join efforts under a logic of territoriality aimed at conserving, sustainably exploiting, and restoring forest ecosystems in the region, seeking to improve the social welfare of its inhabitants.
2. Integrate the different CONAFOR instruments to create synergies, and minimize deforestation and degradation.
3. Promote the conservation, restoration, and management of the forest ecosystems of the Coastal Basins in the state of Jalisco.
4. Promote the strengthening of local capacities for organization and territorial management in owners and users of forest lands.
5. Develop, strengthen and consolidate local development processes with owners and possessors of forest land to improve the traditional management of resources under community silviculture development schemes.
6. Promote the payment of environmental services, which encourage the preservation of natural resources in the Coastal Basins in the state of Jalisco.

7. Promote development schemes through the technical improvement of forest use and good management practices.
8. Collaborate in the preparation and implementation of fire management plans.

2014

National Forest Program PRONAFOR

This year, different supports are operated through PRONAFOR, but it changes the components from IV to VI and only maintains the component V, Environmental services. The components considered for the 2013 financial year (*Diario Oficial de la Federación*, 2013c) are:

I. STUDIES AND PROJECTS COMPONENT

Objective: Support diagnostics, studies (technical and social), and integral projects of silviculture development to base, justify, articulate, guide, and sequence the beneficiaries' actions effectively and efficiently regarding the activities of conservation and restoration, production, and productivity, production chains, environmental services and other processes linked to the country's sustainable silviculture development.

II. CAPACITY DEVELOPMENT COMPONENT

Objective: Develop and improve the planning, organization, instrumentation, and management capacities and skills of the inhabitants, shared lands, communities, and social organizations present in the country's forest areas, to promote, strengthen and consolidate comprehensive silviculture development processes, considering the lessons learned from the community forest development model.

III. FOREST RESTORATION AND PRODUCTIVE RECONVERSION COMPONENT

Objective: Support comprehensive actions and projects for forest restoration and productive reconversion to recover the capacity and natural potential of forest soils and forest cover under conditions of deterioration and gradually recover the ability to provide environmental goods and services.

IV. PRODUCTION AND PRODUCTIVITY COMPONENT

Objective: Promote and support comprehensive actions and projects for the use of timber and non-timber forest resources, and the diversification of productive potential, under the principles of sustainable forest management, by granting a package of subsidies aimed at improving silviculture practices, conservation of biodiversity, and improvement of infrastructure, silviculture modernization and silviculture certification.

V. ENVIRONMENTAL SERVICES COMPONENT

Objective: Support owners of forest land who voluntarily decide to participate in the program of payment for environmental services to incorporate good management practices to promote conservation and sustainable management of ecosystems, and encourage provision in the long term of environmental services, such as water harvesting, maintenance of biodiversity and carbon sequestration and conservation, which benefit population centers or the development of productive activities.

VI. PRODUCTIVE CHAINS COMPONENT

Objective: Promote the creation, organization, training, equipment, support, monitoring, and consolidation of silviculture companies and production chains, to diversify and increase the production and competitiveness of the silviculture sector.

Health Program

The program plans to support the execution of sanitation activities in ecosystems and forest plantations for combatting and controlling pests or diseases, avoiding their loss, and promoting their persistence, as well as that of the associated resources (CONAFOR, 2014).

Special Forest Conservation and Restoration Projects

It maintains the same objectives as in 2012 and 2013.

Commercial Forest Plantations PFC

Continues unchanged from 2012 and 2013

National Silviculture Program PRONAFOR - Priority Hydrographic Basins

This program remains the same as in previous years, wherever it was implemented. But, this year, no support is allocated for the Nevado de Toluca.

Program to promote local payment mechanisms for environmental services through concurrent funds

It remains the same as in the previous years, 2012 and 2013

Silviculture Community Development of the Southern States DECOFOS

The DECOFOS program continued to operate in 2014 without suffering changes, running the same as in 2012 and 2013. It maintains the objective of supporting activities to strengthen the target population's organizational capacity and social capital. As well as to generate planning tools in productive activities and management of economic resources that promote local community development processes and contribute to the mitigation or adaptation to climate change (CONAFOR, 2014b).

REDD+ Early Action Areas Special Program

The Special Program for Early Action Areas REDD+ was proposed to direct support, incentives, and actions to promote Sustainable Rural Development, take full advantage of the diversity of resources present in forest ecosystems and contribute to the reduction of deforestation and degradation of forests and jungles (CONAFOR, 2014c).

The program was executed in Campeche, Chiapas, Jalisco, Quintana Roo, and Yucatán. Additionally, this management has the following purposes:

a) Promote technical studies that identify production and management alternatives for the conservation of natural resources and recovery of deforested and degraded areas;

b) Promote the strengthening of capacities in shared lands and communities for the organization, administration, management, conservation, restoration, and sustainable use of natural resources;

c) Develop, strengthen and consolidate rural development processes based on the social and economic valuation of biological diversity and ecosystem resources offered by forests, taking advantage of local knowledge and their traditional management;

d) Promote the productive management of forest resources taking advantage of both technical and scientific information, as well as local knowledge and traditional forest management;

e) Promote the payment of environmental services, in different modalities, that encourage the preservation of natural resources;

f) Promote productive diversification through managing projects and sustainable use of wildlife, timber, and non-timber forest products.

g) Train shared lands and communities in fire prevention, protection, and management.

h) Promote the establishment of agroforestry, silvopastoral systems, and other innovative production schemes that simultaneously guarantee the provision of food to the people who inhabit the forests and restore degraded areas in an integral, complementary, and/or focused manner;

i) Promote and launch community plans for fire prevention, protection, and management;

j) Promote sustainable development schemes through the technical improvement of forest use, as well as good practices of sustainable management of natural resources;

k) Promote, support, and guide efforts to conserve and restore the regions' ecosystems.

l) Promote the protection, restoration, and conservation of ATREDD+ ecosystems by inducing natural regeneration, reforestation, riverbank restoration, and activities focused on forest protection.

Program for the Promotion of Social Organization, Planning, and Regional Forest Development (PROFOS)

PROFOS continues to operate, as it did in 2012 and 2013, only making minor adjustments to the program's purpose, which is to coordinate the operation, allocation, and execution of federal resources by the National Forest Commission. Its purpose is to strengthen organizations of the silviculture sector (OSSF) in the development of capacities for the planning, organization, and execution of projects of regional scope, as they are considered fundamental actors in the sustainable silviculture development of the country. Said actors aim to regulate the support operation established in article 2 of this guideline (CONAFOR, 2014d).

Institutional Support in the implementation of Training Events and Projects, Education, Technology Transfer, and Silviculture

These support the allocation of resources to the implementation of community development projects (eco-technical demonstration modules) in forest communities, as well as holding congresses, seminars, courses, workshops, technology transfer demonstration events, symposiums, forums, doctoral stays, academic exchanges, technology transfer thematic networks and other events dealing with matters of relevance to the silviculture sector. The projects were organized by public and private institutions or organizations aimed at professionals, technicians, public servants, providers of silviculture technical services and environmentalists, residents, owners and producers of forest regions, students, and civil society in general (CONAFOR, 2014e).

Environmental Compensation Program for Change in Land Use on Lands CUSTF

This program has continued since 2012 and aims to achieve environmental compensation through successful projects that consider soil restoration, reforestation, maintenance, and protection actions, designed strictly with technical and environmental criteria and made by hedgers following said criteria (CONAFOR, 2014f).

Support for Innovation and Technology Transfer

They were generated as economic support for innovation and technology transfer in production processes and the transformation of forest products. The processes have guidelines that aim to establish the rules and procedures of general application, which must be observed in the selection, qualification, allocation, operation, execution, follow-up, evaluation, and conclusion of the requested resources (CONAFOR, 2014g).

Biodiversity Heritage Fund

This fund allocates funds to the granting of payment for environmental services linked to biodiversity, the implementation of appropriate management practices in the area of the property subject to support, and provides technical assistance support (CONAFOR, 2014).

2015

National Forest Program PRONAFOR

The program's objective for this year is to contribute to the incorporation of Mexico's forest area, preferably owners or possessors of forest area, into comprehensive processes of conservation, restoration, and sustainable use (*Diario Oficial de la Federación,* 2014).

It maintains components I, II, II, and V for this year for 2014 and the same objectives. For this exercise, new features are implemented: IV Silviculture, supply, and transformation, as well as VI Commercial Forest Plantations,

Objective: Promote and support actions for the execution of the activities contained in the management programs and studies for the use of timber and non-timber forest resources, as well as optimize the productive potential, under the principles of sustainable forest management that include the conservation of biodiversity, the improvement of regional infrastructure or at the farm level, technological innovation for the modernization of silviculture operations, projects for the generation of energy through the use of forest biomass, forest certification and, the process of productive chains, community or private silviculture companies for the transformation and commercialization of forest products.

V. Environmental Services Component

VI. Commercial Forest Plantations Component

Objective: Promote the establishment and maintenance of Commercial Forest Plantations to increase forest production and productivity in the country, including technological innovation for modernizing silviculture operations in Commercial Forest Plantations.

Components handled within PRONAFOR 2015

Forest Conservation and Restoration Special Projects Program

The goals from 2012 remain unchanged for the program.

Health Program

The program that began in 2014 has continued with the same objectives since its creation.

Environmental Compensation

The program continues in this exercise, only a name change is made, but it maintains practically the same objectives set since 2012.

Innovation and Technology Transfer

As in the previous year (2014), there are no changes in the objectives and guidelines for the program's application.

Silviculture Community Development of the Southern States DECOFOS

It remains unchanged as in the previous three years.

Program for the Promotion of Social Organization, Planning, and Regional Forest Development (PROFOS)

It does not change and has remained the same since it was created and implemented in 2012.

Program to promote local payment mechanisms for environmental services through concurrent funds

There are no material changes in the fiscal year 2015, for the program remains the same as in 2012.

REDD+ Early Action Areas Special Program

There are no changes for 2015 compared to the first year of implementation (2014).

2016

National Forest Program PRONAFOR

This year's components I, III, IV, V, and VI remain the same as in 2015 (*Diario Oficial de la Federación*, 2015). Component II modifies the name and is "Governance and capacity development" with an objective with minimal modifications

Specific mechanisms for the prevention, control, and combat of environmental contingencies caused by pests and diseases and forest fires

This program assigns specific mechanisms for preventing, controlling, and combatting environmental contingencies caused by pests, forest diseases, and forest fires (CONAFOR, 2016).

Concerning pests and diseases, the following actions are supported:

Phytosanitary treatments

Community forest health brigades

Attention to phytosanitary contingencies

Regarding forest fires, support is focused on rural forest fire brigades.

Criteria for plant production of the National Silviculture Program

Designed to set standards for plant production from the design and construction of nurseries, monitoring the production and quality of the plants, to their delivery.

Environmental Compensation

The program is maintained, under the same name as in the two previous years, and there are also no changes to the objectives set since its execution in 2012.

Criteria for Obtaining Germplasm from the National Silviculture Program

The objective is to obtain improved genetic material, considering the priority forest species and of adequate origins, to supply the areas to be restored and commercial plantations in terms of quality and quantity, considering their adaptation to climate change effects (CONAFOR, 2016).

Biodiversity Heritage Fund

This program is once again executed under the same name used back in 2014, with the same goals.

2017

National Forest Program PRONAFOR

The same components implemented in 2015 and 2016 remain this year. Notice that the elements I, II, and IV increased their subcomponents and activities.

As in previous years, the operating rules seek to contribute to the forest area and, preferably, forest area in Mexico, to having enabling conditions developed for its protection, conservation, restoration, and sustainable forest use, through the execution of the components, concepts, and support modalities (*Diario Oficial de la Federación*, 2016).

Environmental Compensation

This program is given continuity, and the objectives are the same as in previous years.

Specific Mechanisms for the Prevention, Control, and Combat of Environmental Contingencies Caused by Pests and Forest Diseases and Forest Fires

The mechanisms continue to be maintained, supporting the same actions handled in 2016.

Criteria for Obtaining Germplasm from the National Silviculture Program

It maintains the same objective as the program implemented in 2016 (CONAFOR, 2017b).

Biodiversity Heritage Fund

The Fund continues without changes compared to 2016, managing the same objectives and operating rules.

Guidelines for conducting Preventive Technical Audits 2017 and Annexes

This year the guidelines for technical audits are integrated, which include annexes to evaluate regeneration, verification of fire prevention and firefighting activities, evaluation of reforestation, and verification of restoration commitments (CONAFOR, 2017c).

2018

Support program for sustainable silviculture development APDFS

The Support Program for Sustainable Forest Development 2018 has as its general objective to contribute to the forest area and preferably forest area in Mexico having enabling conditions developed for its protection, conservation, restoration, and sustainable forest use, through the execution of the components, concepts and support modalities (*Diario Oficial de la Federación*, 2017).

The six components considered in the 2017 financial year remain.

Environmental compensation

The program is maintained as in previous years, achieving environmental compensation through successful projects that consider soil restoration, reforestation, maintenance, and protection actions, strictly designed with technical and environmental criteria and carried out by compensators (CONAFOR, 2017).

Specific mechanisms for prevention, control, and combat of environmental contingencies caused by pests and forest fires, supported by the support program for sustainable silviculture development

The mechanisms remained with the same activities considered in 2016 and 2017.

Criteria for obtaining germplasm from the support program for sustainable silviculture development

This activity continued with the same objective and criteria used since 2016.

Preventive technical audits (ATP)

Continuity is given to the ATP, using the same annexes of the year 2017.

Criteria for plant production of the National Forest Program 2018

As of 2016, these criteria have been established again. Their objective is to develop the requirements that plant producers must observe to ensure the production, availability, and supply of forest plants for the Support Program for Sustainable Forest Development (CONAFOR,2017d).

2019

Support program for sustainable silviculture development APDFS

This year the APDFS changed the name of component I calling it Technical Forest Studies, intending to support the preparation of studies to obtain authorization for the legal use of timber and non-timber forest resources.

Components II and V remain unchanged for 2018, adding new activities to components IV and VI. Component VII is included this year to prevent, combat, and control pests and forest fires, reducing them to ecologically acceptable levels in the different forest ecosystems at a national level. It supports phytosanitary treatments, attention to phytosanitary contingencies, and rural forest fire brigades (*Diario Oficial de la Federación*, 2019).

Components managed within PRONAFOR 2019

Specific mechanisms for prevention, control, and combat of environmental contingencies caused by pests and forest fires, supported by the support program for sustainable silviculture development

These mechanisms were created to regulate component VII. The Forest Environmental Contingencies (CAF) aim to prevent, combat, and control pests and forest fires, reducing them to ecologically acceptable levels in the different forest ecosystems at a national level. It supports phytosanitary treatments and cares for phytosanitary contingencies and rural forest fire brigades (CONAFOR, 2019a).

Biodiversity Heritage Fund

It remains unchanged from previous years, maintaining the same objective in its operating guidelines. The Fund's resources must be used to pay for environmental services linked to biodiversity, the implementation of appropriate management practices in the property subject to support, and technical assistance support (CONAFOR, 2019b).

Criteria for obtaining germplasm from the support program for sustainable silviculture development

It remains unchanged from 2016, 2017, and 2018, keeping the same goal.

2020

Support program for sustainable silviculture development

This year there are some changes in the components, these are the following (*Diario Oficial de la Federación*, 2020):

COMPONENT I. Community Forest Management and Value Chains (MFCCV)

Objective: Support the owners, legitimate possessors, and inhabitants of forest areas to implement actions that allow them to strengthen governance, capacity development, social, technical, cultural, and technology transfer Strengthen the management, cultivation, use, and certification of timber and non-timber forest resources; also, the processes of supply, transformation and

markets of raw materials and forest products; as well as the owners and holders of temporary forest land or preferably forest land for the development of sustainable commercial forest plantations that contribute to increasing the country's forest production.

COMPONENT II. Forest Restoration of Micro-basins and Strategic Regions (RFM)

Objective: Support comprehensive forest restoration projects in micro-basins and strategic regions of the country with a focus on Integrated Land Management (ITM) through practices that contribute to recovering the productivity of degraded forest ecosystems, as well as generating employment and improving the well-being of the shared lands, communities, indigenous peoples and small owners of forest land.

COMPONENT III. Environmental Services (SA)

Objective: Promote the active conservation of forest ecosystems through economic incentives to owners or legitimate owners of forest land who voluntarily decide to incorporate areas to pay for environmental services. Also, to promote the concurrence of financial and operational resources between CONAFOR and parties interested in setting up local mechanisms to support strategic areas that should be incorporated into active conservation schemes to maintain environmental services. The previous objectives are to integrate good management practices to promote ecosystem conservation and sustainable management and encourage the long-term provision of environmental services, and procedures for the benefit of the population, such as water collection, maintenance of biodiversity, capture, and carbon conservation to contribute to the mitigation and adaptation of climate change effects.

COMPONENT IV. Forest Protection (PF)

Objective: Prevent, combat, and control pests and forest fires to reduce the deterioration of various forest ecosystems at a national level by supporting for phytosanitary treatments, attention to phytosanitary contingencies, forest sanitation brigades, and rural forest fire brigades.

Environmental Compensation 2020

For this exercise, the guidelines mention that its purpose is to establish the requirements and procedure to carry out compensation for environmental damage caused by changes in land use on legally authorized forest land through the mechanisms to access the economic resources deposited in the Mexican Forest Fund. Done through the development and implementation of forest restoration projects by third parties; direct administration of projects and expenditures for forest protection by the Commission (*Diario Oficial de la Federación*)

These guidelines are mandatory for public servants of the National Forest Commission who participate in the Environmental Compensation Program and voluntary third parties. They are specific objectives of these guidelines.

I. Establish the bases to carry out forest restoration projects in which a restoration strategy is implemented to promote soil erosion control, surface runoff reduction, aquifer recharge, and recovery of coverage forest.

II. Promote technically and economically feasible projects that integrate a detailed proposal of technical restoration activities for environmental compensation based on the characteristics of the sites to be intervened.

III. Promote detailed information on the ecosystems where environmental compensation actions are carried out.

IV. Establish mechanisms to supervise and monitor environmental compensation projects through criteria and indicators to assess that the restoration trajectory is progressing positively.

V. Establish the bases for the disbursement of resources for forest protection from the deposits made in the Mexican Forestry Fund for environmental compensation.

Annex IV

Table 1 Different platforms that handle restoration aspects (Source: Own elaboration)

ADMINISTERING INSTITUTION	PLATFORM	SCALE	Restoration Themes	Linking to other platforms in the sector	Binding with international/ global platforms	It has restoration shapes	Develop geoprocesses	Observations
CONAGUA	Geographic Information System of Aquifers and Basins (SIGACUA)	National	They are indirectly approached through repositioned layers of information that, after analysis geo processes, allow evaluating the concordance of restorative actions with areas of low water availability or closed aquifers, among others.	No	No	No	No	Does not apply
CentroGeo	ISTHMUS	Regional	They are indirectly approached through repositioned layers of information that, after analysis geo processes, allow evaluating the concordance of restorative actions with areas of economic pressure to deforestation or municipalities with varying degrees of marginalization.	No	Yes	No	No	Does not apply
SEMARNAT	Yucatan Peninsula	Regional	They are indirectly approached through repositioned layers of information that, after analysis geo processes, allow evaluating the concordance of restorative actions with risk areas associated with deforestation zones.	No	No	No	It allows to measure areas and distances	Does not apply
SEMARNAT	SIORE	National	They are indirectly approached through repositioned layers of information that, after analysis geo processes, allow evaluating the concordance of restorative actions with the forest cover of Mexico, sites with ecological ordering, and terrestrial eco-regions	Yes	No	No	It allows to load Shapes, draw and select areas	Does not apply
SEMARNAT	online maps	National	They are indirectly approached through repositioned information layers that, after analysis geo processes, allow evaluating the concordance of restorative actions with forest cover and land use.	Yes	Yes	No	Allows to load Shapes, draw and select areas	Interaction with other information systems is carried out through a direct connection with URL
CONABIO	Geoinformation Portal 2021	National	They are indirectly approached through repositioned information layers that, after analysis geo processes, allow evaluating the concordance of restoration actions with priority restoration zones, priority forest restoration zones, potential distribution areas of species at risk, and types of vegetation.	No	No	Yes	No	Layers are available for download in various formats
CONABIO	Climate Change and Biodiversity Explorer	National	They are indirectly approached through repositioned layers of information that, after analysis geo processes, allow evaluating the concordance of restorative actions with priority restoration zones and forest restoration zones, areas of lower cost for ecological connectivity at a country level.	Yes - Forwards to official pages	Yes - Forwards to official pages	Yes	It allows to load KML, draw and select areas	Layers are available for download in various formats

ADMINISTERING INSTITUTION	PLATFORM	SCALE	Restoration Themes	Linking to other platforms in the sector	Binding with international/ global platforms	It has restoration shapes	Develop geoprocesses	Observations
CONAFOR	Spatial data IDEFOR	National	Repository of polygons associated with Reforestation programs, basins, Hydrological and Priority Restoration Zones, and Priority Forest Restoration Zones.	No	No	Yes	No	Layers are available for download in various formats
CONAFOR	Forest Fire Danger Prediction System	National	They are indirectly approached through repositioned information layers. The polygons supported by CONAFOR in basin restoration, reforestation, and environmental compensation programs are presented here. After geoprocessing, it is possible to evaluate the concordance of the restoration actions with areas categorized based on dangers of forest fire, fire risk, and fires fought, among others.	No	No	No	It allows to measure areas and distances	Does not apply
CONANP	Information System, Monitoring and Evaluation for Conservation (SIMEC)	National	They are indirectly approached through repositioned layers of information that, after analysis geo processes, allowing the evaluation of concordance of restorative actions with land uses.	Yes - CONANP's own repositories	No	No	No	The platform redirects to sets of information (reports) generated for different purposes such as the fulfillment of AICHI goals
CONAFOR	National Information and Forest Management System SNIGF	National	It contains information on the evaluations of commercial forest plantations and reforestation for restoration and conservation purposes. Additionally, it presents layers of geographic information that, when processed through spatial processes, allows knowing the concordance of restoration actions with different categories of forest zoning.	not with all	not with all	Yes	No	It is not updated and lacks all the information at a national level and by year
SEMARNAT	National Environmental and Natural Resources Information System	National	It has diverse topics: the green jobs generated per year and the percentage of GDP invested in compensation and remediation actions. This information can help build comparative analyzes based on investment amounts associated with restoration activities in Mexico.	Yes	Not indicated	It does not have spatial information, but it does have database repositories in editable format that can be spatialized.	No	It does not have a defined theme

ADMINISTERING ENTITY	PLATFORM	Access Link
CONAGUA	Geographic Information System of Aquifers and Basins (SIGACUA)	https://sigagis.conagua.gob.mx/aprovechamientos/
CentroGeo	ISTHMUS	http://istmo.centrogeo.org.mx/interactive/layers
SEMARNAT	Yucatan Peninsula	https://geomaticaportal.semarnat.gob.mx/arcgisp/apps/webappviewer/index.html?id=d27ab46d7a3d48a5bc57b265011b245c
SEMARNAT	SIORE	https://gisviewer.semarnat.gob.mx/aplicaciones/uga_oe2/
SEMARNAT	online maps	https://gisviewer.semarnat.gob.mx/geointegrador2Beta/index.html
CONABIO	Geoinformation Portal 2021	http://www.conabio.gob.mx/informacion/gis/
CONABIO	Climate Change and Biodiversity Explorer	https://servicios.conabio.gob.mx/ECCBio/

ADMINISTERING ENTITY	PLATFORM	Access Link
CONAFOR	Spatial data IDEFOR	https://idefor.cnf.gob.mx/interactive/layers#
CONAFOR	Forest Fire Danger Prediction System	http://forestales.ujed.mx/incendios/inicio/
CONANP	System of Information, Monitoring and Evaluation for Conservation (SIMEC)	https://simec.conPNA.gob.mx/
CONAFOR	National Information and Forest Management System SNIGF	https://snif.cnf.gob.mx/
SEMARNAT	National Environmental and Natural Resources Information System	https://www.gob.mx/semarnat/acciones-y-programas/sistema-nacional-de-informacion-ambiental-y-de-recursos-naturales?idiom=es

Annex V

Methodological Sheet Summary

This annex describes the layers of geographic information used in analyzing the impact of the restoration implemented in Mexico during 2011-2020, particularly concerning questions 11-16 of the methodology section.

Both layers of information used for preparing each data set are presented, as well as their author, a link to access the original data, a brief description, and the analysis carried out from them.

Likewise, information is provided on the preprocessing so it can be used according to the methodological framework. Each data set is ordered in the same sequence stated in this study's main text.

I**mportant note**: The description of each layer has been extracted literally from the web portals of each indicated reference so that its content is directly attributable to the authors of the material in question.

Percentage of poverty by municipality

Layers of geographic information used

- **Layer name**: Percentage of population living in poverty by municipality 2020.

  Author: CONEVAL
  Link: https://www.coneval.org.mx/Measurement/Paginas/Pobreza-municipio-2010-2020.aspx

Analysis

Through the GIS and using the Mexico municipalities layer, a new layer was created that contains the percentage of poverty per municipality. This information was integrated into the general database of the project.

Vulnerability to Municipal Climate Change

Layers of geographic information used

- **Layer name**: Municipal political division 2018. National Institute of Statistics and Geography (INEGI). Scale 1:250,000.

  Author: INEGI
  Link: http://www.conabio.gob.mx/informacion/metadata/gis/muni_2018gw.xml?_httpcache%20=%20yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent%20=%20no
  Layer information: Provides information on the localities and geostatistical limits of Mexico.

- **Layer name**: Municipalities Vulnerable to Climate Change 2019. National Council for the Evaluation of Social Development Policy (CONEVAL).

  Author: CONEVAL
  Link:
  https://www.gob.mx/cms/uploads/attachment/file/681172/PECC-2021-2024.pdf
  Layer information:

Analysis

On Monday, November 8, 2021, the Diario Oficial de la Federación published the Decree approving the 2021-2024 Special Climate Change Program. This Decree contains a map of 273 municipalities vulnerable to climate change that are classified as priority by the Ministry of Welfare. (Executive Power, 2021).

Not having the names of the municipalities and only having the image of the map, a georeferencing cartographic process was carried out to overlay the image obtained on a municipal layer and thus able to shade the 273 vulnerable municipalities.

Priority Sites for Restoration (PRS)

Layers of geographic information used

- **Layer name**: Municipal political division 2018. National Institute of Statistics and Geography (INEGI). Scale 1:250,000.
  Author: INEGI
  Link: http://www.conabio.gob.mx/informacion/metadata/gis/muni_2018gw.xml?_httpcache%20=%20yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent%20=%20no
  Layer information: Provide information on the localities and geostatistical limits of Mexico.

Analysis

The SPR layer is in raster format and not municipalized, so it was cut using the Mexican municipalities layer as a template. A GIS union of the restoration priorities was also carried out to have a single classification and be able to obtain how much percentage of each municipality have SPR. The information was extracted from the layer and integrated into the general database of the project.

Protected Area in different categories by municipality

Layers of geographic information used

- Layer name Municipal political division 2018. National Institute of Statistics and Geography (INEGI). Scale 1:250,000.

  Author: INEGI
  Link: http://www.conabio.gob.mx/informacion/metadata/gis/muni_2018gw.xml?_httpcache%20=%20yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent%20=%20no
  Layer information: Provide information on the localities and geostatistical limits of Mexico.

- **Layer name**: Natural Protected Areas 2021. National Commission of Natural Protected Areas (CONANP).
  Author: CONANP
  Link: http://sig.conPNA.gob.mx/website/pagsig/info_shape.htm

Analysis

A new layer was calculated using the previous layers and obtained with the percentage of each municipality containing Protected Natural Areas (PA) in their different categories. This process was carried out using the GIS ArcGIS Pro, cutting the PA layer using the municipalities layer as a template and integrating the corresponding metadata.

Municipal Connectivity

Layers of geographic information used

- **Layer name**: Municipal political division 2018. National Institute of Statistics and Geography (INEGI). Scale 1:250,000.

  Author: INEGI
  Link: http://www.conabio.gob.mx/informacion/metadata/gis/muni_2018gw.xml?_httpcache%20=%20yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent%20=%20no
  Layer information: Provide information on the localities and geostatistical limits of Mexico.

- **Layer name**: Land use and vegetation Series VII (National continuum) 2018. National Institute of Statistics and Geography (INEGI). Scale 1: 250,000.
  Author: INEGI
  Link: http://www.conabio.gob.mx/informacion/metadata/gis/usv250s6gw.xml?_httpcache=yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent=no

- **Layer name**: Land use and vegetation Series IV (National continuum) 2009. National Institute of Statistics and Geography (INEGI). Scale 1: 250,000.
  Author: INEGI
  Link: http://www.conabio.gob.mx/informacion/metadata/gis/usv250s6gw.xml?_httpcache=yes&_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent=no

Analysis

A new layer of information was created containing only the natural or primary vegetation of each municipality's Land Use and Vegetation of Series IV and Series VII. The process was carried out through the GIS cutting each layer of land used by the municipality. The areas and perimeters of each patch of vegetation in each territorial subdivision of the country were also calculated for each layer, later the IP calculation procedure reported by Alarcon (2017) and described in the methodology section. A comparison was generated between the classifications contemplated in each case to homogenize the categories present in the references of land use under analysis, determining that for the types of vegetation considered, there is no variation in the land use series. They classified the different original categories in abstractions to facilitate the analysis, which is presented in the following Table.

Original Categorization	Series in which it is present		General Category
Oak forest	7	5	Forest
Oak-pine forest	7	5	
Mesquite forest	7	5	
Fir forest	7	5	
Pine forest	7	5	
Pine-oak forest	7	5	
Tascate forest	7	5	
Mountain mesophyll forest	7	5	
Chaparral	7	5	Chaparral
Crasicaule scrub	7	5	Scrub
Rosetophilous desert scrub	7	5	
Halophilic grassland	7	5	Pastureland
High mountain meadow	7	5	High mountain prairie
High evergreen forest	7	5	High evergreen forest
Low deciduous forest	7	5	Low deciduous forest
Tulle	7	5	Tulle

Protected Natural Areas (PA)

Layers of geographic information used

- **Layer name**: Natural Protected Areas 2021. National Commission of Natural Protected Areas (CONANP).
  Author: CONANP
  Link: http://sig.conPNA.gob.mx/website/pagsig/info_shape.htm

Analysis

Carrying out a cutting process with the GIS, the PAs that converge there were sectioned in the shape of the work polygons. This process allows knowing which PAs are immersed in the restoration polygons.

Areas Voluntarily Destined for Conservation (ADVC)

Layers of geographic information used

- **Layer name**: Areas Voluntarily Destined for Conservation 2021. National Commission of Natural Protected Areas (CONANP).
- **Author**: CONANP
- **Link**: http://sig.conPNA.gob.mx/website/pagsig/info_shape.htm

Analysis

Carrying out a cutting process with the GIS, the ADVCs that converge were sectioned in the shape of the polygons of the Great Layer. This process allows knowing which ADVCs are immersed in the restoration polygons.

Priority Sites for Restoration (SPR) and for conservation (SAP)

Layers of geographic information used

- **Layer Name**: Priority Sites for Restoration in Mexico
- **Author**: CONABIO

Link: http://geoportal.conabio.gob.mx/metadatos/doc/html/spr_gw.html

Analysis

Carrying out a cutting process with the GIS, the SPR, and SAP that converge were sectioned to the shape of the work polygons. This process allows knowing what type of priority are the sites that link with the polygons of the Great Layer.

Potential distribution of endangered and threatened species in Mexico

- Layer name: Points of historical record of species in the National System of Information on Biodiversity (SNIB).
- Author: CONABIO
- Link : https://enciclovida.mx/

Analysis

For this analysis, 54 sets of points of the species that have PACE were downloaded. According to CONANP, these are “structured strategies for each species considered in the Program for Conservation of Species at Risk (PROCER), for the recovery of their populations at a national level. They aim to consolidate, promote and implement specific actions and conservation strategies for populations of priority species in Mexico. Unlike other recovery programs in the past, PACE programs are structured and executed with the active participation of all the actors related to the species in question, in a scheme of co-participation and co-responsibility”. PACE can be found at the following address https://www.gob.mx/conPNA/acciones-y-programas/programas-de-accion-para-la-conservacion-de-especies-pace-123484

From the sets of recording points, a 3 km radius buffer was made with each issue, considered a possible area of mobility for each species, according to Foppen (2000). These radii were overlapped on the INEGI series VII Land Use and Vegetation layer to select only those in which the primary land and vegetation use or those that allowed displacement were found in at least half of the area or more. For this, all land uses associated with resistance to displacement of species less than 50% were considered, according to Gurrutxaga (2003). The land Uses and Vegetation used are listed below: Cultivated Forest, Forest, Chaparral, Man-

grove, Scrub, Mezquital, Natural Palm Grove, Pasture, High Mountain Meadow, Savannah, High Evergreen Forest, Low Forest, Medium Forest, Tular, Vegetation of sandy deserts, the Vegetation of coastal dunes, Riverside vegetation, Halophytic vegetation, and Secondary arboreal vegetation.

This selection of buffers was considered as areas with potential permeability, and the work polygons were overlapped on them, selecting only those where there was a coincidence between them and the permeability areas. For the above, GIS cutting and intersection tools were used.

Annex VI

Indicators of green growth in Mexico

Document title: Set of green growth indicators, indicator 2.1.1 Green employment.

Reference: Semarnat. Environment and Natural Resources Sectorial Program 2013-2018. Semarnat. Mexico. 2016

Objective: The purpose of the green jobs indicator is to measure the number of employed people dependent on an entity in any economic activity that protects and benefits the environment or makes sustainable use of natural resources through its production processes, the production of final goods, and actions to prevent or reduce environmental damage.

Available at: https://apps1.semarnat.gob.mx:8443/dgeia/indicadores_verdes16/indicadores/04_innovacion/2.1.1.html

Document title:

- AGREEMENT by which the reference costs for reforestation or restoration and their maintenance for environmental compensation for land use change in forest lands and the methodology for their estimation are issued – 2006
- AGREEMENT by which the reference costs for reforestation or restoration and their maintenance for environmental compensation for land use change in forest lands and the methodology for their estimation are issued – 2014
- Operating Rules of the Support Program for Sustainable Forest Development 2018.

Reference:

CONAFOR. (2006). AGREEMENT through which the reference costs for reforestation or restoration and their maintenance for environmental compensation for land use change in forest lands and the methodology for their estimation are issued. Daily Federation Officer. _ CdMx. Mexico.

CONAFOR. (2014). AGREEMENT through which the reference costs for reforestation or restoration and their maintenance for environmental compensation for land use change in forest lands and the methodology for their estimation are issued. Daily Federation Officer. _ CdMx. Mexico.

CONAFOR. (2018). Operating Rules of the Support Program for Sustainable Forest Development. Daily Federation Officer. _ CdMx. Mexico.

Objective: Calculate the reference costs for reforestation or restoration activities and their maintenance.

Available in:

- https://www.dof.gob.mx/nota_to_doc.php?codnota=2123662 .
- https://www.dof.gob.mx/nota_detalle.php?codigo=5354722&fecha=31/07/2014
- https://www.gob.mx/conafor/documentos/regulas-de-operacion-2018

IMPORTANT NOTE: The information presented below is entirely extracted from the indicated reference, so its content is directly attribuTable to the authors of the material in question.

Description (Summary of findings):

The types of vegetation of the INEGI series II were grouped for each ecosystem to simplify ecological heterogeneity and facilitate the recognition of the significant discontinuities in the landscape on a national scale, also adding the type of climate according to the Keppen classification. Forest vegetation was grouped, facilitating the location of the different vegetation types in Mexico. This helped determine reference costs.

Once the ecosystems were determined and according to their ecological characteristics, the minimum activities required for each one were established to guarantee the minimum level of restoration that would allow ecological succession to begin.

The calculation to determine the costs of restoration or reforestation activities and their maintenance for environmental compensation was based on labor and machinery yields, or their inverse, that is, the consumption of labor time or machinery and equipment time for the construction of a particular work, charges for consumption, the inputs or raw materials used in an assignment, and other expenses such as staff travel costs or transportation of materials.

The performance of labor was calculated based on the experiences in carrying out a specific restoration, reforestation or maintenance work or practice, measured directly in the field for:

- Ditch side with machinery
- Individual terraces
- Reforestation with planting shovel
- Plant transportation
- Terraces or ditch side at level (manual)
- Living wall terraces
- Weeding on individual terraces
- Stabilization of slopes for reforestation
- Technical advice
- Opening of firebreak gaps
- Fencing with wooden post
- Breaking or ripping with bulldozer
- Mangrove restoration

The number of wages necessary for its execution was calculated according to the type of work or activities required. The labor, machinery, and equipment charges were calculated based on the yields for implementing an assignment. Also, all the expenses that apply to each activity, indicating labor costs involved in restoration or reforestation works and their maintenance, were considered.

Labor charges are calculated by multiplying the labor cost required to carry out the work (specialized and non-specialized) by the labor consumption of the activity or practice to be carried out.

In the case of activities carried out with machinery, the values were calculated using the formulas established in the Law on Public Works and Related Services.

Tabla 1 Equivalence of wages by type of activity

Intervention level 1	Intervention level 2	Intervention level 3	Equivalent activity	Reference	Wages/ha
Improving access to water for native fauna			Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05
Natural regeneration	Passive natural regeneration	Reduce or eliminate sources of degradation	Land clearing and trench marking	CONAFOR 2014	0.3
	Assisted natural regeneration	Scarification	Maintenance practices	CONAFOR 2006	19
		Grazing management	Maintenance practices	CONAFOR 2006	19
		Vegetation management	Clear the ground of vegetation	CONAFOR 2014	6.6
		Fire management (firebreak gaps)	Opening of firebreak gaps	CONAFOR 2014	twenty
		Species reintroduction	Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05
		Farmer assisted natural regeneration	Maintenance practices	CONAFOR 2006	19
		Autochthonous recolonization	Fencing with wooden posts	CONAFOR 2014	21.23
		Restoration of flood regimes	Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico.	See green growth indicators	26.4
		Soil improvement	Soil conservation	CONAFOR 2006	70
		Phytoremediation	Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico.	See green growth indicators	26.4
		Reestablish hydrological connectivity	Restoration of priority basins. Calculation based on the amount per hectare and the cost of the daily wage per year of reference.	CONAFOR 2018	93
		Intensive withdrawal from grazing	Fencing with wooden posts	CONAFOR 2014	21.23
		Elimination of non-native species	Weeding or plot clearing	CONAFOR 2014	3
		Removal of excessive native vegetation	Weeding or plot clearing	CONAFOR 2014	3
		Slope stabilization	Slope stabilization	CONAFOR 2014	35.58
		Creation of habitat for pollinators	Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices).	CONAFOR 2018	8.05
		Pest control by creating habitat for predators	Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices).	CONAFOR 2018	8.05

Intervention level 1	Intervention level 2	Intervention level 3	Equivalent activity	Reference	Wages/ha
Artificial regeneration	Plantation		Forest plantations	CONAFOR 2014	130
	Terrace		Terraces	CONAFOR 2014	34.09
	Other forms of soil manipulation		Soil conservation	CONAFOR 2006	70
	Replanting with native species		Sowing seed	CONAFOR 2014	0.5
	Bush planting		Forest plantations	CONAFOR 2014	130
	Soil enrichment		Fertilization	CONAFOR	1
	Basin management		Restoration of priority basins. Calculation based on the amount per hectare and the cost of the daily wage per year of reference.	CONAFOR 2018	93
	Channel management		Soil excavation for opening or reopening of canals.	CONAFOR 2014	194.8
	Groundwater management		Establishment of ditch systems.	CONAFOR 2014	1
	Erosion reduction (retention channels)		Opening of runoff diversion ditches to prevent erosion.	CONAFOR 2014	2.5
	Reduction of the contribution of nutrients from the basin		Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico.	See green growth indicators	26.4
	Capture of sediment flows		Opening of runoff diversion ditches to prevent erosion.	CONAFOR 2014	2.5
	Wave energy reduction		Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico.	See green growth indicators	26.4
	Mangrove plantation		Establishment of the mangrove plant on the site.	CONAFOR 2014	43.89
	Restoration of traditional mowing/grazing systems		Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico.	See green growth indicators	26.4
	Revegetation with characteristic species		Sowing seed.	CONAFOR 2014	0.5
	Elimination of invasive vegetation		Weeding or plot clearing.	CONAFOR 2014	3
	Prevention of illegal mining		Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico.	See green growth indicators	26.4
	Management of integrated productive spaces (including activities such as conservation tillage, integrated manure systems, crop diversification, and others).		Agroforestry systems (Calculation based on the amount per hectare and the cost of the daily wage per reference year).	CONAFOR 2018	31.55
	Interventions aimed at water management		Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico.	See green growth indicators	26.4
Land / water protection / conservation actions	Establishment of conservation areas		Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices).	CONAFOR 2018	8.05
	Plantation/Seeding/Regeneration of buffer zones		Reforestation with planting shovel	CONAFOR 2014	7.2
	Step planting		Reforestation with planting shovel	CONAFOR 2014	7.2
	Planting/Seeding of corridors of mixed stands		Reforestation with planting shovel	CONAFOR 2014	7.2
	Reintroduction of fauna and bird species		Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05
Control of invasive species			Weeding or plot clearing	CONAFOR 2014	3
Management of native invasive species and diseases			Weeding or plot clearing	CONAFOR 2014	3
Artificial natural regeneration	Planting of seedlings or seeds in mixtures		Reforestation with planting shovel	CONAFOR 2014	7.2
	Planting on steep slopes and along watercourses		Reforestation with planting shovel	CONAFOR 2014	7.2
	Prey removal		Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico	See green growth indicators	26.4

Intervention level 1	Intervention level 2	Intervention level 3	Equivalent activity	Reference	Wages/ha
	Improved water quality		Restoration of priority Basins (Calculation based on the amount per hectare and the cost of the daily wage in the reference year)	CONAFOR 2018	93
	Forest reconnection		Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05
Silviculture			Reforestation with planting shovel	CONAFOR 2014	7.2
Plantation of forests and forest plots			Reforestation with planting shovel	CONAFOR 2014	7.2
Agroforestry / silvopastoral systems			Agroforestry systems (Calculation based on the amount per hectare and the cost of the daily wage per reference year)	CONAFOR 2018	31.55
Basins' protection and erosion control			Works for the control of laminar erosion (Ditches, Sides)	CONAFOR 2014	35.12
Application of participatory management systems with local land users			Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico	See green growth indicators	26.4
Protection of places/areas/ habitats			Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05
Restoration of hydrology (Opening of channels for restoration of water flows)			Soil excavation for opening or reopening of canals	CONAFOR 2014	194.8
Site Preparation			Land clearing	CONAFOR 2014	0.3
Improving the quality of surface waters to promote the recolonization of native species			Restoration of priority basins Calculation based on the amount per hectare and the cost of the daily wage per year of reference)	CONAFOR 2018	93
Artificial fencing to prevent sand loss/ erosion (dunes)			Fencing with wooden posts	CONAFOR 2014	21.23
Converting gray infrastructure to green			Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico	See green growth indicators	26.4
Restoration of urban waterways to semi-natural conditions			Restoration of priority basins (Calculation based on the amount per hectare and the cost of the daily wage per year of reference)	CONAFOR 2018	93
Creation of blue spaces			Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico	See green growth indicators	26.4
Restoration of catchment areas			Soil conservation	CONAFOR 2006	70
Increased extent and complexity of tree canopies			Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05
Creation / enhancement of habitat for native wildlife species			Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05
Creation of wild gardens			Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico	See green growth indicators	26.4
Creation of green spaces / green belts			Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05

Intervention level 1	Intervention level 2	Intervention level 3	Equivalent activity	Reference	Wages/ha
Creation of green roofs Development of peri-urban food systems			Standardized conversion factor for restoration activities not indicated in official references of the environmental sector in Mexico	See green growth indicators	26.4
Improved land management (agricultural fields)			Agroforestry systems (Calculation based on the amount per hectare and the cost of the daily wage per reference year)	CONAFOR 2018	31.55
Biodiversity enhancement			Practices in properties with timber production (induced regeneration, soil removal, fencing, biodiversity management and conservation, activities to achieve regeneration establishment and management, site-level practices)	CONAFOR 2018	8.05

Source: Own elaboration.

Annex VII

Table 1 Land uses and vegetation in Mexico and their equivalence with the ecosystem typology of the Bonn Challenge

Categorization of Land Use and Vegetation Series VII INEGI	Simplified Categories of Land Use in Mexico (Own Preparation)	Corresponding type of restoration interventions as of RITTE
Annual moisture agriculture	Agriculture	Farmlands and mixed-use areas
Annual and semi-permanent moisture agriculture	Agriculture	Farmlands and mixed-use areas
Semi-permanent and permanent moisture agriculture	Agriculture	Farmlands and mixed-use areas
Annual irrigation agriculture	Agriculture	Farmlands and mixed-use areas
Annual and permanent irrigation agriculture	Agriculture	Farmlands and mixed-use areas
Annual and semi-permanent Irrigation Agriculture	Agriculture	Farmlands and mixed-use areas
Permanently irrigated agriculture	Agriculture	Farmlands and mixed-use areas
Semi-permanently irrigated agriculture	Agriculture	Farmlands and mixed-use areas
Semi-permanent and permanent irrigation agriculture	Agriculture	Farmlands and mixed-use areas
Annual rainfed agriculture	Agriculture	Farmlands and mixed-use areas
Annual seasonal and permanent agriculture	Agriculture	Farmlands and mixed-use areas
Annual and semi-permanent seasonal agriculture	Agriculture	Farmlands and mixed-use areas
Permanent temporary agriculture	Agriculture	Farmlands and mixed-use areas
Semi-permanent seasonal agriculture	Agriculture	Farmlands and mixed-use areas
Temporary, semi-permanent and permanent agriculture	Agriculture	Farmlands and mixed-use areas
Human settlements	Human settlements	Urban areas
Cultivated forest	Cultivated forest	Forests and woodlands
Ayarin forest	Forest	Forests and woodlands
Cedar forest	Forest	Forests and woodlands
Oak forest	Forest	Forests and woodlands
Oak-pine forest	Forest	Forests and woodlands
Mesquite forest	Forest	Forests and woodlands
Oyamel forest	Forest	Forests and woodlands
Pine forest	Forest	Forests and woodlands
Pine-oak forest	Forest	Forests and woodlands
Tascate forest	Forest	Forests and woodlands
Forest induced	Forest	Forests and woodlands
Mountain mesophyll forest	Forest	Forests and woodlands
Chaparral	Chaparral	Grasslands, shrublands and savannahs
Water body	Water body	Rivers, streams and lakes
Devoid of vegetation	Devoid of vegetation	Other
Mangrove swamp	Mangrove swamp	Coasts and mangroves
Crasicaule scrub	Scrub	Deserts and semi- deserts
Microphyll desert scrub	Scrub	Deserts and semi- deserts
Rosetophilous desert scrub	Scrub	Deserts and semi- deserts
Tamaulipas thorny scrub	Scrub	Deserts and semi- deserts
Coastal rosetophyllous scrub	Scrub	Deserts and semi- deserts
Sarcocaule scrub	Scrub	Deserts and semi- deserts
Sarco-Crasicaule scrub	Scrub	Deserts and semi- deserts
Mist sarco-crasicaule scrub	Scrub	Deserts and semi- deserts
Submontane scrub	Scrub	Grasslands, shrublands and savannahs
Subtropical scrub	Scrub	Grasslands, shrublands and savannahs

Categorization of Land Use and Vegetation Series VII INEGI	Simplified Categories of Land Use in Mexico (Own Preparation)	Corresponding type of restoration interventions as of RITTE
Tropical mesquital	Mesquital	Deserts and semi- deserts
Xerophile mesquital	Mesquital	Deserts and semi- deserts
Induced palmar	Induced palmar	Deserts and semi- deserts
Natural palm grove	Natural palm grove	Deserts and semi- deserts
Cultivated pasture	Cultivated pasture	Farmlands and mixed-use areas
Gypsophila grassland	Pastureland	Grasslands, shrublands and savannahs
Halophilic grassland	Pastureland	Grasslands, shrublands and savannahs
Induced grassland	Pastureland	Grasslands, shrublands and savannahs
Natural grassland	Pastureland	Grasslands, shrublands and savannahs
High mountain prairie	Pastureland	Grasslands, shrublands and savannahs
Savannah	Savannah	Grasslands, shrublands and savannahs
Sabanoid	Savannah	Grasslands, shrublands and savannahs
High evergreen forest	High evergreen forest	Forests and woodlands
Deciduous forest	Deciduous forest	Forests and woodlands
Low spiny deciduous forest	Low jungle	Forests and woodlands
Low spiny sub evergreen forest	Low jungle	Forests and woodlands
Medium deciduous forest	Medium jungle	Forests and woodlands
Medium evergreen forest	Medium jungle	Forests and woodlands
No apparent vegetation	No apparent vegetation	
Tulle	Tulle	Rivers, streams and lakes
Sandy desert vegetation	Sandy desert vegetation	Deserts and semi- deserts
Coastal dune vegetation	Coastal dune vegetation	Coasts and mangroves
Riverside vegetation	Riverside vegetation	Rivers, streams and lakes
Hydrophilic halophilic vegetation	Halophytic vegetation	Coasts and mangroves
Halophytic xerophytic vegetation	Halophytic vegetation	Deserts and semi- deserts
Cedar forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Oak forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Oak-pine forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Mesquite forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Oyamel forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Pine forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Pine-oak forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Táscate forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Arboreal secondary vegetation of mountain mesophyll forest	Secondary vegetation	Forests and woodlands
Mangrove arboreal secondary vegetation	Secondary vegetation	Coasts and mangroves
Arboreal secondary vegetation of high evergreen forest	Secondary vegetation	Forests and woodlands
Arboreal vegetation Secondary of high sub evergreen forest	Secondary vegetation	Forests and woodlands
Arboreal secondary vegetation of deciduous forest	Secondary vegetation	Forests and woodlands
Arboreal secondary vegetation of spiny deciduous low forest	Secondary vegetation	Forests and woodlands
Arboreal secondary vegetation of prickly sub evergreen low forest	Secondary vegetation	Forests and woodlands
Arboreal secondary vegetation of medium deciduous forest	Secondary vegetation	Forests and woodlands
Medium sub deciduous forest arboreal secondary vegetation	Secondary vegetation	Forests and woodlands
Arboreal secondary vegetation of medium sub evergreen forest	Secondary vegetation	Forests and woodlands

Categorization of Land Use and Vegetation Series VII INEGI	Simplified Categories of Land Use in Mexico (Own Preparation)	Corresponding type of restoration interventions as of RITTE
Oak forest secondary bushy vegetation	Secondary vegetation	Forests and woodlands
Oak-pine forest secondary bushy vegetation	Secondary vegetation	Forests and woodlands
Mesquite forest shrubland secondary vegetation	Secondary vegetation	Forests and woodlands
Oyamel forest shrub secondary vegetation	Secondary vegetation	Forests and woodlands
Pine forest bushy secondary vegetation	Secondary vegetation	Forests and woodlands
Pine-oak forest bushy secondary vegetation	Secondary vegetation	Forests and woodlands
Táscate forest bushy secondary vegetation	Secondary vegetation	Forests and woodlands
Secondary bushy vegetation of mountain mesophyll forest	Secondary vegetation	Forests and woodlands
Chaparral shrub secondary vegetation	Secondary vegetation	Grasslands, shrublands and savannahs
Mangrove shrub secondary vegetation	Secondary vegetation	Coasts and mangroves
Crasicaule shrubland secondary vegetation	Secondary vegetation	Deserts and semi- deserts
Shrubland secondary vegetation	Secondary vegetation	Deserts and semi- deserts
Desert scrub bushy secondary vegetation	Secondary vegetation	Deserts and semi- deserts
Bushy secondary vegetation of Tamaulipas thorny scrub	Secondary vegetation	Deserts and semi- deserts
Secondary bushy vegetation of coastal rosetophyllous scrub	Secondary vegetation	Deserts and semi- deserts
Sarcocaule shrubland secondary vegetation	Secondary vegetation	Deserts and semi- deserts
Sarco-crasicaule shrubland secondary vegetation	Secondary vegetation	Deserts and semi- deserts
Sarco-crasicaule de nebli bushy secondary vegetation	Secondary vegetation	Deserts and semi- deserts
Submontane scrub bushy secondary vegetation	Secondary vegetation	Grasslands, shrublands and savannahs

Annex VIII

Spatially explicit polygons and intervention areas in the decade by state

Condition	Number of spatially explicit projects	Area (ha)
AGUASCALIENTES	291	12811.67
LOWER CALIFORNIA	180	5889.81
BAJA CALIFORNIA SOUTH	171	10388.57
CAMPECHE	394	5213.93
CHIAPAS	930	19057.92
CHIHUAHUA	765	49214.68
MEXICO CITY	80	3628.33
COAHUILA	292	25465.17
COLIMA	418	10660.98
DURANGO	904	43929.23
MEXICO STATE	1917	51380
GUANAJUATO	530	28198
WARRIOR	1059	68070
GENTLEMAN	1399	20718
JALISCO	864	34407
MICHOACAN	1797	44066.72
MORELOS	494	21125.35
NAYARIT	746	47935.60
NEW LION	312	25576.79
OAXACA	395	13981.66
PEOPLE	1648	41726.69
QUERETARO	369	15111.54
QUINTANA ROO	434	23367.46
SAN LUIS POTOSI	301	20455.48
SINALOA	445	18296.07
SOUND	324	38477.81
TABASCO	340	5778.53
TAMAULIPAS	230	7564.86
TLAXCALA	546	13886.58
VERACRUZ	2638	24881.65
YUCATAN	418	7521.53
ZACATECAS	415	34741.44

Annex IX

Table 1 List of species and risk categories, in which there was an incidence of restorative actions in relation to the calculated permeability radii

Row labels	Endemism	Name-059	Red list
Abronia Grass	endemic	Threatened	Endangered
Abronia Lythrochila	NA	Threatened	Least concern
Abronia Taeniata	endemic	Special protection	Endangered
Alouatta Palliata	NA	Endangered	Vulnerable
Oratrix Amazon	NA	Endangered	Endangered
Aquila Chrysaetos	NA	Threatened	Least concern
Ara Militaris	NA	In danger of extinction	Vulnerable
Ateles Geoffroyi	NA	Endangered	Endangered
Canis Lupus	NA	NA	Least concern
Crocodylus Acutus	NA	Special protection	Vulnerable
Crotalus Basiliscus	endemic	Special protection	Least concern
Crotalus Molossus	NA	Special protection	Least concern
Crotalus Ravus	endemic	Threatened	Least concern
Crotalus Triseriatus	endemic	NA	Least concern
Cynomys Mexicanus	endemic	In danger of extinction	Endangered
Diospyros Xolocotzii	NA	In danger of extinction	Na
Leopardus Pardalis	NA	In danger of extinction	Least concern
Leopardus Weedii	NA	In danger of extinction	Near threatened
Odochoileus Hemionus	NA	NA	Least concern
Oreophasis Derbianus	NA	In danger of extinction	Endangered
Panthera Onca	NA	In danger of extinction	Near threatened
Pharomachrus Mocinno	NA	In danger of extinction	Near threatened
Rhynchopsitta Terrisi	endemic	In danger of extinction	Endangered
Rhynchopsitta Pachyrhynchus	endemic	In danger of extinction	Endangered
Romerolagus Diazi	endemic	In danger of extinction	Endangered
Sarcoramphus Papa	NA	In danger of extinction	Least concern
Spizaetus Melanoleucus	NA	In danger of extinction	Least concern
Spizaetus Ornate	NA	In danger of extinction	Near threatened
Spizaetus Tyrannus	NA	In danger of extinction	Least concern
Spizella Wortheni	endemic	In danger of extinction	Endangered
Tapirella Bairdii	NA	In danger of extinction	Endangered
Tayasu Peccary	NA	NA	Vulnerable

Annex X

Table 1 Simplified classifications of land use in Mexico and their equivalence with the categories for the Bonn Challenge and average SOC value per hectare

IUCN ecosystem	INEGI ECOSYSTEM	SOC PER HA
Other	AQUACULTURE	46.97
Cultivated and mixed-use areas	FARMING	63.09
Urban areas	SETTLEMENTS	58.82
Forests and woodlands	FOREST	87.46
Forests and woodlands	CULTIVATED FOREST/ PERMANENT FOREST PLANTATION	81.10
Forests and woodlands	INDUCED FOREST	31.22
Grasslands, shrublands and savannahs	CHAPARRAL	59.47
Rivers, streams and lakes	WATER BODIES	74.68
Other	DEVOID OF VEGETATION	77.90
Coasts and mangroves	MANGROVE SWAMP	115.23
Deserts and semi -deserts	SCRUB	43.59
Deserts and semi -deserts	MESQUITAL	39.32
Other	INDUCED PALMAR	71.82
Other	NATURAL PALM TREE	77.00
Grasslands, shrublands and savannahs	PERMANENT CULTIVATED PASTURE	71.67
Grasslands, shrublands and savannahs	GYPSOPHILO PASTURELAND	49.13
Grasslands, shrublands and savannahs	HALOPHYL GRASSLAND	31.26
Grasslands, shrublands and savannahs	INDUCED PASTURE	64.83
Grasslands, shrublands and savannahs	NATURAL GRASSLAND	45.97
Rivers, streams and lakes	POP	106.76
Grasslands, shrublands and savannahs	HIGH MOUNTAIN MEADOW	141.08
Grasslands, shrublands and savannahs	SAVANNAH	87.81
Grasslands, shrublands and savannahs	SABANOID	63.64
Forests and woodlands	JUNGLE	88.09
Other	NO APPARENT VEGETATION	48.01
Rivers, streams and lakes	TULAR	120.05
Deserts and semi -deserts	SANDY DESERT VEGETATION	10.74
Coasts and mangroves	VEGETATION OF COASTAL DUNES	60.39
Rivers, streams and lakes	RIVERSIDE VEGETATION	33.39
Other	PETEN VEGETATION	107.53
Deserts and semi-deserts	GYPSOPHILA VEGETATION	48.58
Coasts and mangroves	HALOPHILIC HYDROPHILIC VEGETATION	61.84
Deserts and semi-deserts	HALOPHY XEROPHYL VEGETATION	23.23
Forests and woodlands	ARBOREAL SECONDARY VEGETATION	88.95
Grasslands, shrublands and savannahs	SECONDARY BUSH VEGETATION	67.66
Grasslands, shrublands and savannahs	HERBACEOUS SECONDARY VEGETATION	82.57
Urban areas	URBAN ZONE	55.28

Annex XI

Table 1 Simplified classifications of land use in Mexico and their equivalence with the categories for the Bonn Challenge, value of annual increase in aerial biomass per hectare and associated carbon fraction based on IPCC data

IUCN Ecosystem	Ecosystem	Annual increase in aerial biomass Ton/Ha	Note	Fraction of C
Other	Aquaculture	Does not apply	There is no standardized conversion factor	Does not apply
Farmlands and mixed-use areas	Agriculture	3.6	Farmland based on agroforestry systems	0.4
Urban areas	Human settlements	2.8	Urban areas (based on C of tree cover within them)	Does not apply
Forests and woodlands	Forest	3.1	Temperate mountain forest less than 20 years old	0.47
Forests and woodlands	Cultivated forest	10	Mountain forest plantation less than 20 years old	0.47
Forests and woodlands	Induced forest	3.1	Temperate mountain forest less than 20 years old	0.47
Grasslands, shrublands and savannahs	Chaparral	4	Subtropical dry forest	0.47
Rivers, streams and lakes	Water bodies	Does not apply	There is no standardized conversion factor	Does not apply
Other	Devoid of vegetation	Does not apply	There was no change, it does not apply	Does not apply
Coasts and mangroves	Mangrove swamp	Does not apply	There is no standardized conversion factor	Does not apply
Deserts and semi-deserts	Scrub	4	Other tropical/subtropical shrub species	0.47
Deserts and semi-deserts	Mesquital	4	Other tropical/subtropical shrub species	1.47
Other	Induced palmar	2.4	Palm (cultivated)	0.47
Other	Natural palm grove	Does not apply	There was no change, it does not apply	Does not apply
Grasslands, shrublands and savannahs	Cultivated grassland	2.8	Average of different applicable climate zones	0.4
Grasslands, shrublands and savannahs	Gypsophilous grassland	Does not apply	There was no change, it does not apply	Does not apply
Grasslands, shrublands and savannahs	Halophilic grassland	Does not apply	There was no change, it does not apply	Does not apply
Grasslands, shrublands and savannahs	Induced grassland	2.8	Average of different applicable climatic zones considering default biomass in grasslands after conversion from other land uses	0.4
Grasslands, shrublands and savannahs	Natural grassland	4	Based on secondary subtropical steppe less than 20 years old	0.4
Rivers, streams and lakes	Popal	0.07	Based on CO_2/C emissions-sinks from land converted to flooded land	Does not apply
Grasslands, shrublands and savannahs	High mountain meadow	23	Based on secondary temperate steppe less than 20 years old	0.4
Grasslands, shrublands and savannahs	Savannah	4	Subtropical steppe	0.4
Grasslands, shrublands and savannahs	Sabanoid	4	Subtropical steppe	0.4
Forests and woodlands	Jungle	5.9	Secondary tropical forest older than 20 years	0.47
Other	No apparent vegetation	Does not apply	There was no change, it does not apply	Does not apply
Rivers, streams and lakes	Tulle	0.07	Based on CO_2/C emissions-sinks from land converted to flooded land	Does not apply
Deserts and semi-deserts	Vegetation of sandy deserts	Does not apply	There was no change, it does not apply	Does not apply
Coasts and mangroves	Coastal dune vegetation	Does not apply	There is no standardized conversion factor	Does not apply
Rivers, streams and lakes	Riverside vegetation	4.0	Based on temperate subtropical forest	0.4
Other	Peten vegetation	0.07	Based on CO_2/C emissions-sinks from land converted to flooded land	Does not apply
Deserts and semi-deserts	Gypsophilous vegetation	Does not apply	There was no change, it does not apply	Does not apply
Coasts and mangroves	Hydrophilic halophilic vegetation	Does not apply	There is no standardized conversion factor	Does not apply
Deserts and semi-deserts	Xerophytic halophytic vegetation	Does not apply	There is no standardized conversion factor	Does not apply

IUCN Ecosystem	Ecosystem	Annual increase in aerial biomass Ton/Ha	Note	Fraction of C
Forests and woodlands	Tree secondary vegetation	3.1	Temperate mountain forest less than 20 years old	0.47
Grasslands, shrublands and savannahs	Shrub secondary vegetation	4	Other tropical/subtropical shrub species	0.47
Grasslands, shrublands and savannahs	Herbaceous secondary vegetation	2.8	Average of different applicable climatic zones considering default biomass in grasslands after conversion from other land uses.	0.4
Urban areas	Urban zone	2.8	Urban areas (based on C of tree cover within them)	Does not apply

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

Regional Office for Mexico, Central America and the Caribbean
(ORMACC)
PO Box: 607-2050 San Pedro Montes de Oca San José, Costa Rica
Phone: +506 22 83 84 49
ormacc@iucn.org
ormacc@iucn.org
www.iucn.org/ormacc
www.iucn.org/resources/publications