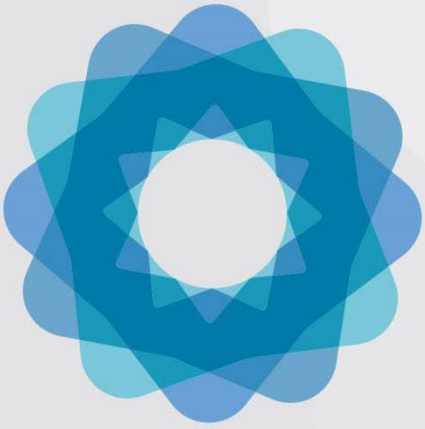

System of Environmental Economic Accounting

MEXICO – Country Assessment Report 2018

Project Natural Capital Accounting and Valuation of Ecosystem Services

Revision 2019

Acknowledgments

This report was prepared by Salvador Sánchez Colón in 2018, edited by Pete Nelson and updated by Fernando Tudela in 2019 as part of the programmed activities for the implementation of the Project Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES) in Mexico.

The Project NCAVES was implemented in Mexico under the leadership of the National Institute of Statistics and Geography (INEGI) with the support of the United Nations Statistics Division and the United Nations Environment Programme (UNEP). The project NCAVES was funded by the European Union.

The views, thoughts and opinions expressed in this report are not necessarily those of the United Nations or European Union or other agencies involved.

Executive summary

In the early 1990's Mexico became one of the first countries in the world to develop environmental economic accounts when the National Institute of Statistics and Geography (INEGI) took part in a pilot project launched by the World Bank. In the intervening years, the Mexican government has developed extensive experience and capacity in relation to natural capital accounting (NCA), particularly through INEGI's annual updates of its Sistema de Cuentas Económicas y Ecológicas de México (Mexico's System of Economic and Environmental Accounts, SCEEM) and its development of the headline indicator Ecologically-Adjusted Net Domestic Product, or PINE according to its Spanish acronym. The nation has also produced a rich body of research on the description and valuation of ecosystem services. This wealth of experience and demonstrated commitment makes Mexico an excellent partner to move the NCA agenda forward through its participation in the Natural Capital Accounting and Valuation of Ecosystem Services project. This assessment looks at the current institutional and policy context in Mexico, its experience with natural capital accounting, and existing and potential policy applications to develop insights for the Mexican and global NCA community.

The Institutional and Policy Context
The importance of natural capital and ecosystem services is recognized in the Mexican policy context, both at national and local levels. Mexico's environmental legislative and regulatory framework refers frequently to ecosystem services and the role of ecosystems and natural resources as the country's natural capital. On the other hand, laws regulating economic or development activities heavily dependent on ecosystem services (e.g., fisheries, tourism, urban development, infrastructure) tend to have a narrow focus and often do not cover biodiversity or other natural capital aspects. Mexico's participation in multilateral agreements like the 2030 Agenda for Sustainable Development, or the United Nations Convention on Biological Diversity, among others, has also helped promote the concepts of natural capital and ecosystem services within the country.

Policy Applications of NCA in Mexico
An early development of economic instruments for environmental protection may be associated with the use of ecosystem accounts to inform policy in Mexico. Federal-level taxes and fees in Mexico include water effluent charges, entrance fees for parks and other protected areas, fuel taxes, and taxes on other products with negative environmental externalities, e.g. pesticides. Mexico has an extensive experience with innovative payment for ecosystem services (PES) schemes, with an emphasis on forest management practices. The Mexican PES programme is relevant worldwide in terms of area covered and funds disbursed. Ecosystem accounting can offer vital information for policy design, particularly for the design of appropriate fee and/or compensation mechanisms.

Monitoring the state of natural capital should play a role in planning and budgeting activities, for instance in the establishment of protected areas. Natural capital accounting and the valuation of ecosystem services may throw light on the relevant connections between the environment and national development.

Insights for the Mexican and International NCA Community

Policy relevance. The assessment shows that mainstreaming ecosystem/biodiversity considerations in Mexican policy making is already underway. Although it has not yet achieved its large potential, this Mexican experience may prove particularly valuable for the international NCA community.

Expanding this experience implies incorporating variables included in environmental-economic accounts

into economic modelling and analyses, using valuation studies to inform the design of economic instruments like taxes, trading programs, and payment for ecosystem services programs, and relying on the results from accounts to orient budgeting and prioritization.

Coordination. Mexico´s institutional structure provides a sound basis for achieving coordination and collaboration among national government agencies. Within the legal framework of the National System of Statistical and Geographic Information (SNIEG), successive national administrations have supported the SCEEM as an important source of information for many government agencies. Options to improve coordination include establishing a high-level national consultative committee, as well as other platforms to strengthen the NCA community in Mexico.

Standardization. The SEEA-EEA can promote the efficiency of Mexico's environmental programmes and help ensure its sustainability. The widespread adoption of a SEEA-EEA's unified, standardized conceptual and methodological approach may improve the general coherence of adopted policies.

Communication. Recognition of the vital importance and value of ecosystems and their services for the adoption of relevant policies and regulations calls for ambitious communication and outreach efforts, as advocated by SEEA-EEA initiatives such as the NCAVES project.

List of acronyms

SEEA	System of Environmental-Economic Accounting
SEEA EEA	System of Environmental-Economic Accounting – Experimental Ecosystem Accounting
SCEEM	Mexico's System of Economic and Environmental Accounts (Spanish acronym)
CONAFOR	National Forestry Commission
SEMARNAT	Secretariat for Environment and Natural Resources (previously SEMARNAP)
SADER	Secretariat of Agriculture and Rural Development (previously SAGARPA)
CONABIO	National Commission for the Knowledge and Use of Biodiversity
INECC	National Institute for Ecology and Climate Change
CONAGUA	National Water Commission
CONANP	National Commission for Natural Protected Areas
SNIARN	National System of Environmental and Natural Resources Information
SNIEG	National System of Statistical and Geographic Information
NCA	Natural Capital Accounting
CNM	Natural Capital of Mexico; Mexico's National Biodiversity Assessment report
ENBioMex	National Strategy on Biodiversity
IPBES	The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Contents

1. Introduction

1.1 Natural Capital Accounting

Natural Capital Accounting (NCA) is an umbrella term covering efforts to use an accounting framework to provide a systematic way to measure and report stocks and flows of natural capital. Its underlying assumption is that if a resource or commodity is important to society and the economy, it should be recognised as an asset that must be maintained and managed, and its contributions (services) be better integrated into commonly used frameworks like the System of National Accounts (SNA).

NCA covers accounting for individual environmental assets or resources, both biotic and abiotic (such as timber, fish, water, minerals, energy), as well as accounting for ecosystem assets (e.g. forests; wetlands) and ecosystem services. Natural capital accounting at an economy-wide level is also known as environmental-economic accounting.

The System of Environmental Economic Accounting (SEEA) is the accepted international standard for environmental-economic accounting, providing a framework for organizing and presenting statistics on the environment and its relationship with the economy. It brings together economic and environmental information in an internationally agreed set of standard concepts, definitions, classifications, accounting rules and tables to produce internationally comparable statistics.

1.2 Project description

The Natural Capital Accounting and Valuation of Ecosystem Services (**NCAVES**) is a 3 year global project implemented jointly by United Nations Statistics Division (UNSD), United Nations Environment Programme, and the UN Convention on Biological Diversity (CBD), with financial support from the European Union. The project aims to advance the knowledge agenda on environmental-economic accounting, particularly ecosystem accounting, by pilot testing the UN System of Environmental Economic Accounts-Experimental Ecosystem Accounting (SEEA-EEA) framework in select countries where biodiversity is at stake: Brazil, China, India, Mexico, and South Africa. Specific objectives are:

- Improving the measurement of ecosystems and their services (both in physical and monetary terms) at the (sub)national level;
- Mainstreaming biodiversity and ecosystems in (sub)national level policy-planning and implementation;
- Contribute to the development of internationally agreed methodology and its use in partner countries.

The project in Mexico was officially launched in June 2017 during a high-level stakeholder workshop and will continue throughout 2020.

The National Institute for Statistics and Geography (INEGI, an autonomous entity since 2008), along with the Secretariat of the Environment and Natural Resources (SEMARNAT) are the main partners in Mexico. Specific entities within SEMARNAT collaborate with the project, such as the National Commission for Biodiversity, (CONABIO, currently based on a inter-sectoral agreement); the National Institute for Ecology and Climate Change (INECC); the National Water Commission (CONAGUA); the National Commission for Protected Areas, (CONANP); the National Forestry Commission (CONAFOR); the Safety, Energy and Environmental Agency (ASEA) .

Outputs of the project will be presented during the 2020 Conference of the Parties to the Convention on Biological Diversity, feeding into the development of the Post 2020 Biodiversity Strategy. The Mexican experience building pilot ecosystem accounts may yield relevant inputs for the revision of the UN SEEA-EEA proposals.

1.3 Purpose of report

The assessment report serves the following purposes:[1]

- Assess the policy landscape, identify policy priorities and country interests to ensure that the ecosystem accounts to be developed will conform to needs so as to be used in policy setting;
- Assess data availabilities and gaps, to guide the choice of the type of ecosystem accounts to be developed;
- Review existing initiatives, programs, and studies to ensure the project will build upon existing capacities and instructional expertise, thus avoiding duplication of efforts.

The assessment report may serve as an input to develop a roadmap for advancing environmental-economic and ecosystem accounting in Mexico, that will specify the medium and long terms objectives for implementing Natural Capital Accounts in Mexico.

1.4 Report outline

Section 2 introduces the institutional and policy context for NCA in Mexico. Section 3 review the literature on ecosystem services valuation for Mexico, data availability for ecosystem accounting, existing NCA-related projects and initiatives. Section 4 discusses existing policy applications, such as taxes, fees and PES schemes. Section 5 provides the overall assessment and includes some recommendations.

[1] In 2014-2015 Mexico took part, along with Bhutan, Chile, Indonesia, Vietnam, Mauritius and South Africa, in the *Advancing Natural Capital Accounting* (ANCA) project, supported by the Norwegian Agency for Development Cooperation (Norad). This report builds upon and updates ANCA´s *Mexico Country Assessment Report 2015*.

2. Institutional and Policy Context

2.1 Mexican legislation, planning and regulatory frameworks

2.1.1 The National Development Plan

Mexico's National Development Plan is the main planning instrument for the Federal Government. It is produced every six years, at the onset of each new presidential administration. The main body of NDP 2019-2024 briefly refers to the issue of [2]"sustainable development": "the Federal Government will consider in every circumstance the impacts derived from its policies and programmes on the social fabric, the ecology and the country´s political and economic horizons". It might be inferred from this legal text that work within the framework of SCEEM could provide useful tools for carrying out the required impacts assessment.

2.1.2 Sectoral programmes

The NDP is meant to guide programming and budgeting across the entire federal administration and to steer the formulation of the federal sectoral programmes of work. No sectoral programme has been published yet, but it may be expected that when they are concluded they will be more explicit on the utilization of SEEA-EEA approaches, as these were mentioned during the public consultative meetings set up by SEMARNAT.

2.1.3 State-level government programmes

In Mexico´s States, government periods do not necessarily correspond to those of the federal administration. Each State government formulates a State-level Development Plan at the onset of its own administration. The information provided hereby corresponds to the situation as of 2018. As Annex A shows, almost all Mexican States (except for the State of Guerrero) include some environmental considerations in their government programmes; the supply or depletion of natural resources (particularly water), waste generation and environmental pollution are widespread concerns. Several State governments also address various aspects of ecosystem management and/or biodiversity conservation. In most cases, however, these themes are included only as part of the planning for other higher-priority issues such as economic growth and/or social development, but not as a priority on their own right. Natural capital and ecosystem services concepts are absent in many programmatic pieces of legislation at the State level. Only 12 out of the 32 existing States (namely: Campeche, Chiapas, Mexico City, Estado de México, Jalisco, Nayarit, Oaxaca, Querétaro, Quintana Roo, Veracruz, Yucatán and Zacatecas) make specific reference in their government´s programme to ecosystem/environmental services or natural capital issues. Only eight of those 12 states specify policies to address them. Reference to ecosystem services focus usually on those stemming from **forest** ecosystems.

2.1.4 Regulatory framework

Mexico's regulatory framework is mainly based on command-and-control mechanisms. Since the establishment of the Secretariat for the Environment, Natural Resources and Fisheries, in 1994, various

[2] PND 2019- 2024; section on "Sustainable Development"; page 37. Published in the Official Journal of the Federation; 12/07/2019.

environmental laws and regulations have been adopted, reformed and enforced. Table 1 below lists the 26 main federal laws that regulate activities involving the occupation, use, management and conservation of the country's territory and natural capital. Laws pertaining to the environmental sector have a comprehensive view and address most major issues, including the recognition of biodiversity, ecosystems and natural resources as the country's natural capital, as well as the value of ecosystem/environmental services.

Table 3.- Environmental themes regulated by major federal-level laws that regulate activities involving the use, occupation and/or management of Mexico's territory and natural resources. [3]

Federal law	Use of natural resources, environmental degradation	Ecosystems	Biodiversity	Natural capital & Environmental or ecosystem services
General law for ecological equilibrium and environmental protection (Ley general del equilibrio ecológico y la protección al ambiente)	✔	✔	✔	✔
General law on wildlife (Ley general de vida silvestre)	✔	✔	✔	✔
General law for sustainable forestry development (Ley general de desarrollo forestal sustentable)	✔	✔	✔	✔
General law on climate change (Ley general de cambio climático)	✔	✔	✔	✔
National waters law (Ley de aguas nacionales)	✔	✔	✔	✔
Federal law on environmental liability (Ley federal de responsabilidad ambiental)	✔	✔		✔
Agrarian law (Ley agraria)	✔			
Law for sustainable rural development (Ley de desarrollo rural sustentable)	✔	✔	✔	✔
Federal law on plant health (Ley federal de sanidad vegetal)	✔			
Federal law on animal health (Ley federal de sanidad animal)	✔			
Law for sustainable fisheries and aquaculture (Ley general de pesca y acuacultura sustentables)	✔	✔		
Law on genetically modified organisms (Ley de bioseguridad de organismos genéticamente modificados)	✔		✔	
Law on organic products (Ley de productos orgánicos)	✔	✔	✔	
General law for tourism (Ley general de turismo)	✔			
General law on human settlements, land-use planning and urban development (Ley general de asentamientos humanos, ordenamiento territorial y desarrollo urbano)	✔			
General law on national goods (Ley general de bienes nacionales)	✔	✔		
Law for energy transition (Ley de transición energética)	✔			
Law for the use of renewable energy and financing energy transition (Ley para el aprovechamiento de energías renovables y el financiamiento de la transición energética)	✔			
Hydrocarbons law (Ley de hidrocarburos)	✔	✔		
Law for electricity industry (Ley de la industria eléctrica)	✔			
Law for geothermal energy (Ley de energía geotérmica)	✔			
Law for the promotion and development of biofuels (Ley de promoción y desarrollo de los bioenergéticos)	✔			

[3] Columns refer to the specific ways of mentioning the issues in each law

Law for general communication routes (Ley de vías generales de comunicación)				
Federal law of the sea (Ley federal del mar)	✔			
Law for maritime navigation and trade (Ley de navegación y comercio marítimos)	✔	✔		
Law on ports (Ley de puertos)	✔			

Laws regulating economic or development activities that are heavily dependent on ecosystem services or that, by their very nature, impact biodiversity and ecosystems (e.g., fisheries, tourism, urban development, infrastructure) often do not cover aspects related to biodiversity or natural capital. At best, they address the use and depletion of natural resources and pollution issues. There is much room for improvement to mainstream NCA considerations in sectoral policies.

2.2 Key agencies in the environmental sector

The Mexican institutional setting for strengthening the environmental / ecosystemic components of the country´s Statistical System is quite robust. Some of its main entities are listed below.

- INEGI is Mexico's National Institute of Statistics and Geography. It has a long-standing programme on SEEA, based on a wide range of spatially explicit information on environmental, economic and social themes, including a long sequence of land-cover / land use maps.

- SEMARNAT (Secretariat of Environment and Natural Resources, formerly SEMARNAP) coordinates the national environment and natural resource information system (SNIARN). SNIARN, is a prize-winning web-based presentation of spatial and statistical data that have been standardized and quality assessed. The SNIARN includes among others:

    - a database (BADESNIARN) with statistical information on topics related to the environment,

    - maps and query possibilities of the environmental characteristics of the country (Digital Geographic Area System - ESDIG) on topics such as vegetation, land use, water bodies, climate, environmental and social programs, and

    - a National System of Indicators (SNIA) that provides a brief overview of the changes and the current state of the environment and natural resources of the country, as well as the pressures and institutional responses for their conservation, restoration and sustainable use.

    - SEMARNAT is the focal point for the CBD. It participates in the elaboration of the Global Environmental Outlook reports (GEO's) and produces regularly a State of the Environment Report.

  The Secretary of SEMARNAT also controls CONABIO; CONAGUA; CONANP; CONAFOR; INECC; PROFEPA; ASEA.

  - CONABIO (National Commission for Knowledge and Use of Biodiversity) is the main Mexican repository of information on biodiversity and its utilization. Linked to the main research centers in the field, CONABIO publishes the most comprehensive reports on the biodiversity aspects of natural capital.
  - CONAGUA (National Water Commission) is in charge of the administration and conservation, in terms of quantity and quality, of national waters and the inherent public goods. With the

participation of users and society at large, working with Federal, State and municipal governments, CONAGUA should ensure the sustainable use of the resource, while undertaking actions to face extreme meteorological events.

- CONANP (National Commission of Natural Protected Areas) is in charge of the conservation of the natural heritage of Mexico through the establishment and management of protected areas.
- CONAFOR (National Forestry Commission) is oriented towards the strengthening of the sustainable development of natural resources in the forest ecosystems through conservation, protection, restoration, support and production actions, with a long-term vision defined in the Strategic Forestry Programme for Mexico 2025. [PRONAFOR: Programa Estratégico Forestal para México 2025].
  CONAFOR produces periodic inventories of forestry resources, including soil aspects.
- INECC (National Institute of Ecology and Climate Change) coordinates, promotes and develops scientific and technological research related to national policy on biosafety, sustainable development, environmental protection, preservation and restoration of ecological balance, conservation of ecosystems and climate change. It is in charge of the evaluation of the Climate Change Special Programme.
- PROFEPA (Federal Attorney for Environmental Protection) is responsible for the enforcement of environmental laws and regulations, including those related to natural resources, other than water (dealt with by CONAGUA).
- ASEA is the Agency for Safety, Energy and Environment, and deals with regulatory and enforcement provisions related to the oil and gas sector.

- SADER (Secretariat of Agriculture and Rural Development, formerly SAGARPA) leads several national sustainable development programmes in the rural areas. It is currently sensitive to environmental aspects related to biodiversity and climate change. The Service of Agri-Food and Fisheries Information (SIAP) is the main source of statistics and geographical information in this sector.
- SEDATU (Secretariat of Agrarian, Land, and Urban Development) is responsible for managing human settlements and land use planning.
- SB (Secretariat of Wellbeing, formerly SEDESOL) is the main federal government`s body for social affairs. It runs a new programme ("Sowing Life", Sembrando Vida) fostering -at a very large scale- some rural productive activities, including tree plantations.
- CENAPRED's (National Centre of Disaster Prevention) mission is to reduce the impact of natural disasters on the population.

2.3 International commitments

In 1972 the Government of Mexico signed the Declaration of the U.N. Conference on the Human Environment (The Stockholm Declaration). Mexico has then been an active participant in most international multilateral processes related to environment and sustainable development. It is a Party to all major multilateral environmental treaties, including the UN Convention on Biological Diversity and arrangements derived from it, the UN Convention to Combat Desertification, the UN Framework Convention for Climate Change and its associated instruments, including the Paris Agreement, the 2030 Agenda and its SDGs, among many others. It also subscribed a set of regional agreements.

Participation in such international agreements has had legal implications at the national level and has led to the formulation and adoption of emerging policies. An outcome of these processes include the recognition and valuation of natural capital and ecosystem services.

2.3.1. 2030 Agenda for Sustainable Development

In 2015, Mexico along with other 192 United Nations member states, committed to achieve the Sustainable Development Goals (SDG) included in 2030 Agenda for Sustainable Development. Of the 17 SDGs, SDG 15 [*Life on Land*] aims in particular to "*…Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss".* Its associated target 15.9 sets the following objective: *"By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts".*

In 2017 Mexico submitted a first Voluntary National Review (VNR) describing the preparatory measures taken to create an enabling environment for implementing 2030 Agenda in Mexico. A second VNR was submitted to the 2018 High-level Political Forum on Sustainable Development, describing the measures taken to implement the 2030 Agenda in Mexico at the federal and subnational levels, progress made on each of the 17 SDGs, as well as the challenges faced and lessons learned over the course of the first three years of the implementation of the Agenda. The report identified the development of *"…capacities and methodologies to measure the economic value of natural goods and services…"* as one standing challenge to implement SDG 15 in Mexico.

The National Strategy for the Implementation of 2030 Agenda in Mexico was published in 2018. Table 2 below shows some of its contents. Although this document should soon be updated by the new administration, in place since the 1st of December 2018, most probably the new Strategy will also include the recognition and valuation of natural capital and ecosystem services as a most useful tool to keep track of the fulfilment of SDGs.

Table 2.- National targets, actions and measures proposed in the 2018 National Strategy for the implementation of 2030 Agenda in Mexico that require recognition and valuation of natural capital and ecosystem services

Goal	Proposed priority national target	Actions/measures proposed
11 Make cities and human settlements inclusive, safe, resilient and sustainable	Promote and implement measures to internalize the externalities caused by the production, demand and supply of urban goods and services, as well as those generated by waste management.	Improve the quality and accessibility of public transport in Mexican cities to reduce its economic, environmental and social costs. Encourage the conservation of biodiversity and ecosystem services, as well as the creation of biodiverse green areas, emphasizing an ecosystem-based approach in order to obtain multiple benefits. Produce information on urban biodiversity and the value of biodiverse green spaces in urban environments; as well as on the impacts of urbanization on biodiversity and ecosystem services (flora and fauna, water quantity and quality, climate change, pollution, waste, land-use change, etc.) in urban zones and their surrounding areas.
12 Ensure sustainable consumption and production patterns		Promote and implement measures to internalize the externalities caused by the production, demand and supply of urban goods and services, as well as those generated by waste management.
13 Take urgent action to combat climate change and its impacts		Mainstream an approach focused on environmental protection, conservation and sustainable use of biodiversity and ecosystem services, and climate risks in all government agencies, as well as in National Development Plans and State-level Government Programmes, with a focus on gender and human rights. Develop fiscal policies and economic and financial instruments to incentivize a reduction of greenhouse gas emissions. Conserve, restore and sustainably manage ecosystems, in order to guarantee the long-term supply of environmental services.
14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Plan and sustainably manage marine and coastal ecosystems by making use of all available instruments (e.g., Protected Areas, Marine Ecological Planning, Fisheries Management);	Update existent —or formulate new— regulations on conservation and protection of marine and coastal zones in order to integrate the sustainable use and protection of natural capital concepts to ensure their consistency and compliance.

	avoid the loss of marine biodiversity and the ecosystem services it provides to society.	Implement, expand and strengthen actions for the rehabilitation and restoration of coastal, insular, riparian, inland aquatic and marine ecosystems according to their biological importance and degree of degradation in order to restore the ecosystem services they supply. Promote the establishment of a system for permanently monitoring the effects of natural disturbances or other anthropogenic pressure factors and threats, as well as the resilience of the environmental services provided by marine and coastal ecosystems, in order to produce information/knowledge in different spatial scales that can inform decision-making and the formulation of public policies, including provisioning, regulatory and cultural ecosystem services. Understand the linkages between large cities and their impacts on the sea, as well as the impacts of climate change on large cities and human settlements, which lead to loss of ecosystem services, droughts, floods and salinization of the coastal area.
15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, particularly forests, wetlands, mountains and arid zones, in compliance with commitments stemming from international agreements. Economic valuation of the country's ecosystem goods and services. By 2020, restore terrestrial, riverine, wetland and coastal ecosystems and the services they provide, with an interdisciplinary, comprehensive, intersectoral, long-term, territorial approach.	Develop and apply methodologies to measure the social and environmental impact of activities carried out by both, government agencies and private entities. Mainstream the various views of valuation of ecosystem goods and services into planning processes. Implement, expand and strengthen actions for the rehabilitation and restoration of terrestrial ecosystems according to their biological importance and degree of degradation in order to restore the ecosystem services they supply.

2.3.2 UN Convention on Biological Diversity (UN-CBD).

As one of the earliest signatories of the UN CBD, and in fulfilment of the commitments embodied therein, the government of Mexico, through CONABIO, conducted and published a first biodiversity country study in 1998 (CONABIO, 1998) and formulated in 2000 a first National Strategy on Biodiversity (CONABIO, 2000). In 2016, CONABIO launched a major collaborative effort to formulate an updated National Strategy on Biodiversity (ENBioMex) and an Action Plan for its implementation over the period 2016-2030 (CONABIO, 2016).

ENBioMex and its action plan is meant to steer the in-country implementation of the UN-CBD's Strategic plan for biodiversity 2011-2020 and attaining the Aichi Biodiversity Targets adopted in 2010 at the UN-CBD's COP10. Particularly relevant in this regard are Aichi Targets 1, 2 and 14:

- Target 1.- By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
- Target 2.- By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems
- Target 14.- By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous peoples, local communities and the poor and vulnerable.

Accordingly, the ENBioMEX's vision states: By 2030 the biodiversity and functionality of ecosystems are maintained, as well as the continued provision of the ecosystem services necessary for the development of life and well-being of Mexicans; government and society are committed to the conservation, sustainable use and fair and equitable distribution of the benefits derived from biodiversity.

The main premise for the formulation of the ENBioMex was that "…the country´s development will only be viable within a framework of sustainability, and this implies the recognition, valuation, conservation and restoration of the ecosystem services provided by biodiversity…". ENBioMex devotes an entire chapter to the many services that the country's ecosystems provide, and it describes the impacts that human activities have had on the ecosystems capacity to provide those.

The ENBioMex comprises six strategic axes with 24 lines of action and proposes over 160 actions/interventions. Most of the strategic axes and many of the lines of action and interventions proposed refer to ecosystems and their services. Annex B lists those which specifically demand, for their implementation, the consideration of natural capital and ecosystem services and respond to Aichi Targets 1, 2 or 14.

CONABIO also engaged in collaborative efforts to support relevant sectors of the Mexican economy to formulate strategies for taking into account the conservation and sustainable use of biodiversity in the sector's productive programmes. Sectoral biodiversity strategies for the agricultural (SAGARPA, 2017), fisheries and aquaculture (SAGARPA-CONAPESCA-INAPESCA, 2016), tourism (SECTUR, 2016) and forestry (SEMARNAT-CONAFOR, 2016) sectors have been completed. Since 2002, CONABIO has also been pursuing similar efforts to support State-level governments to formulate their state-level strategies for biodiversity. As of to date, all the 32 states of the Mexican federation have completed their local strategy on biodiversity.

2.3.3 The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

IPBES is an independent intergovernmental body that seeks to strengthen the science-policy interface between biodiversity and ecosystem services and the conservation and sustainable use of biological diversity, the long-term well-being of people and sustainable development.[4] Its objective is to build bridges between science and policy-making so that decision-makers have scientific grounds to properly consider and include the conservation and sustainable use of biodiversity into policy and regulatory systems.

The IPBES provides governments, academia and other international organizations with policy-relevant knowledge on biodiversity and ecosystem services for better-informed decision-making, achieving synergies and complementarity. World-renowned experts, academics and scientists, government officials, civil society organizations, local communities and indigenous peoples participate in IPBES assessments.

IPBES´s membership currently includes 132 countries. IPBES´S four main functions are:

- Assessment. - Develop global, regional and thematic assessments on biodiversity and ecosystem services.
- Knowledge generation. - Catalyse efforts to generate new knowledge.
- Support for policy tools. - Identify relevant tools and methodologies, facilitate their use and promote and catalyse their further development.
- Capacity building. - Prioritize capacity building needs and request and provide financial and

[4] https://www.biodiversidad.gob.mx/planeta/internacional/ipbes.html

other support to address them.

Mexico joined IPBES as a founding member in April 2012. CONABIO is Mexico's focal point for the platform and over 70 Mexican experts are actively involved in IPBES´s assessments. On August 2, 2018, IPBES formally announced that Mexico will host the Technical Support Unit for the *Assessment of diverse conceptualizations of multiple values of nature and its benefits*. UNAM (National Autonomous University of Mexico), with support from CONABIO and financial support from GIZ (German Cooperation Agency), will coordinate this TSU, to be located in Morelia, México.

3. Natural Capital Accounting and Valuation of Ecosystem Services in Mexico

Work on natural capital accounting and ecosystem services valuation in Mexico has closely tracked developments taking place in the international arena. Since the early 1990s, the Government of Mexico particularly through its nascent Secretariat of the Environment, Natural Resources and Fisheries, eventually transformed into SEMARNAT, and INEGI, along with the country's academic sector as well as international and local environmental NGOs, have engaged in compiling and disseminating integrated environmental and economic accounts, as well as conducting research on ecosystem services valuation. This section highlights the development of the SEEA activities in Mexico.

3.1 History of SEEA in Mexico

In 1990-1991, Mexico's National Institute of Statistics and Geography (INEGI) took part in a pilot project launched by the World Bank with technical support from the UN Statistical Office (UNSO; currently the UN Statistics Division, UNSD). The project aimed at integrating and linking environmental and economic information using UNSD's Draft Handbook on Environmental Accounting as analytical framework and to explore whether environmentally adjusted national product aggregates for Mexico could be derived. Results from that pilot study were first published in the World Bank's report "*Integrated Environmental and Economic Accounting. A Case Study for Mexico"* (World Bank, 1991).

Building upon those initial results, INEGI launched an institutional effort to compile country-wide environmental and economic accounts and integrate these into Mexico's National Accounts as a *satellite account*. Since 1996, INEGI has been compiling and publishing annual updates of Mexico's *System of Economic and Environmental Accounts*, SCEEM. These accounts are constructed following the guidelines of the international statistical standard, the UN System of Environmental and Economic Accounting (SEEA) and, over time, have incorporated methodological and data base improvements, as well as further developments of the SEEA (UN 1993, 2003, 2014). Currently, Mexico's SCEEM includes specific accounts for water, forests (physical and monetary balance sheets), fisheries (catch data for 13 species that are subject to unsustainable exploitation), and materials flows (biomass from agriculture, forestry, fishing, and grazing, also includes water, fossil fuels and non-metallic minerals), as well as an estimate of the country's environmental protection expenditures. (INEGI, 2018). Biodiversity as such was not included in these exercises.

A main product stemming from SCEEM is the Ecologically Adjusted Net Domestic Product (PINE, according to its Spanish acronym). This indicator provides information on the impacts of economic activities on the environment and natural resources by deducting the costs of natural resources depletion and environmental degradation from the country's Net Domestic Product. Figure 1 shows the latest figures reported by Mexico's SCEEM for the last ten years.[5]

[5] The depletion of hydrocarbons stocks is monetized by estimating the change in the value of stocks. The replacement cost method is used to value the depletion of forest resources (due to the clearing of harvest forests, the conversion of forest lands to other productive land-uses and the loss of forest cover to other land-uses). The replacement cost includes the costs of reforestation works (seedling production, planting, and maintenance) necessary to reforest the same amount of forest land. Ground water depletion is valued in terms of shadow prices calculated based on the production costs at water facilities (INEGI, 2017).
The maintenance cost method is used to estimate the costs of soil degradation and air and water pollution, by estimating the minimum expenses that would be incurred in order to restore or avoid the loss of the assets' initial condition. For soil erosion, this is based on the cost of remediation works needed to restore the land productivity. The costs of air and water pollution are estimated based on the expenses (as imputed costs) that would be necessary to reduce pollution levels to meet current quality standards. For water pollution, this was based on the operation costs of wastewater treatment facilities. The costs associated to air pollution were estimated by considering the remedial

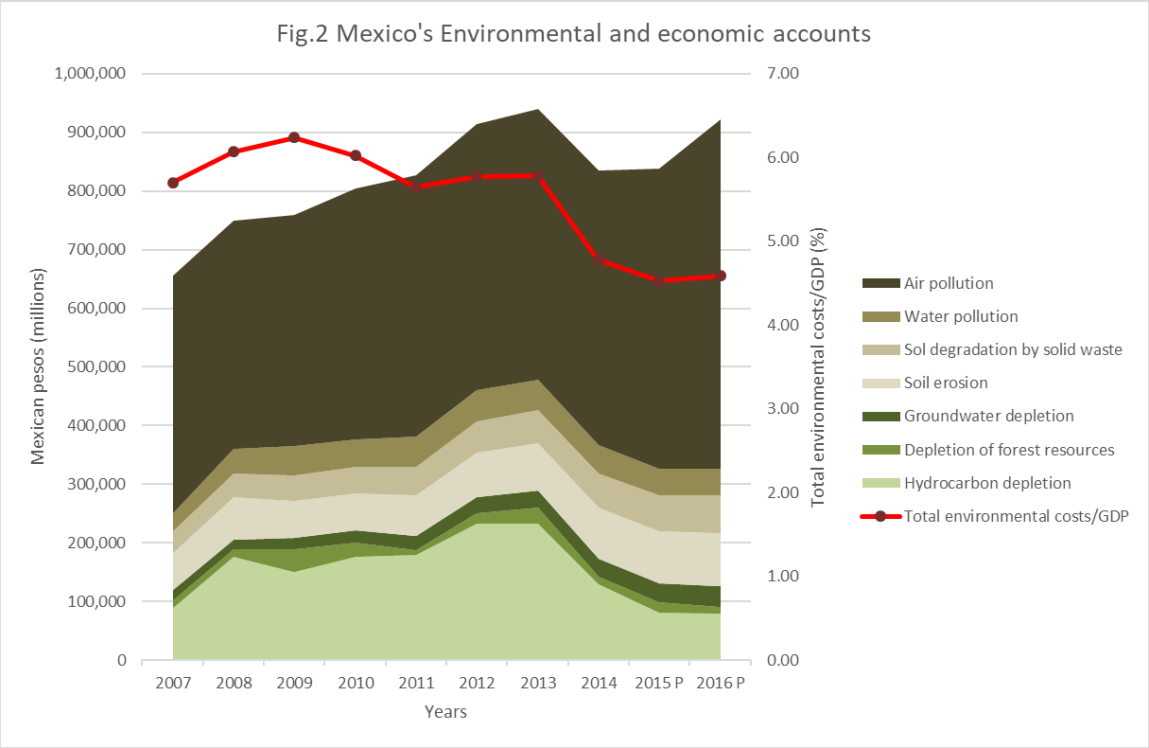

Figure 1. Mexico's Ecologically Adjusted Net Product 2007-2016 (base year: 2013). Costs of environmental degradation (air, water and soil) are displayed in shades of brown; components shown in shades of green represent the costs of natural resources depletion (hydrocarbons, forests and ground water). For comparison, the red line shows total environmental costs as a percentage of the country's GDP. Figures for the years 2015 and 2016 are preliminary estimates.

Mexico's National Development Plan 2001-2006 selected PINE as one of the indicators to assess the sustainability of Mexico's economic growth (DOF, 2001). Similarly, the National Development Plan 2007-2012 pointed out that, over the period 1996-2003, the annual monetary cost of environmental degradation amounted to as much as 10.4% of the country's GDP on average and that, were this trend to continue, the country's economic growth and the Mexicans' well-being would be jeopardized. The National Development Plan 2013-2018 pointed out that, in 2011, the cost of environmental depletion and degradation in Mexico amounted to as much as 6.9% of the country's GDP and that this "…imposes major challenges to promote economic growth and development while ensuring that natural resources continue providing the environmental services upon which the Mexicans' well-being depends…" (DOF, 2013). Accordingly, the environmental sectoral programme (PROMARNAT) derived from NDP 2013-2018 has adopted INEGI's total cost of environmental degradation and depletion as the main indicator for the programme's "Objective 5.- Halt and revert the loss of natural capital and water, air and soil pollution", and has set the target of reducing this indicator to 4.5% by 2018. It is still unclear how the follow up on the current National Development Plan (2019- 2024) will make use of the PINE indicator.

3.2 Ecosystem services assessment and valuation in Mexico

There has been in Mexico a sustained interest on natural capital accounting and the valuation of

technologies and mechanisms included in air quality improvement programmes. The cost of soil degradation by untreated municipal solid waste is estimated based on the costs of treatment, handling and final disposal, as estimated for Mexico City facilities (INEGI, 2017).

ecosystem services, particularly in the academia and the environmental government sector, but also among environmental NGOs, both domestic and international, that operate in the country. Since the establishment of Mexico's first Secretariat of the Environment, Natural Resources and Fisheries (SEMARNAP) in 1994, valuating in monetary terms environmental damages and ecosystem degradation was introduced to complement with economic instruments regulatory frameworks previously based only on less efficient command-and-control mechanisms. (García López, T. 2018).

Mexico's very first biodiversity country study (CONABIO, 1998) devoted an entire chapter to the economic valuation of Mexico's resources (de Alba & Reyes, 1998), describing results from a few early case studies of economic valuation, along with those from SCEEM. The authors emphasized the need to conduct economic valuation studies of key processes (e.g., land-use change, depletion of ground water sources), ecosystems (marine, arid, mountain and mangrove ecosystems) and activities (e.g., fishing and hunting, eco-tourism, firewood collection, protection of species at risk), and the importance of compiling the results in a unified data base. CONABIO then built upon these preliminary studies, proposed strategic actions ((Sarukhán, 2012), and developed an ambitious set of documents under the headline of *Mexico´s Natural Capital*.

3.2.1 Capital Natural de México (CNM)

The most comprehensive assessment of Mexican ecosystems and the services they provide is to be found in the volumes of "*Capital Natural de México*" (CONABIO 2006, 2008a, 2008b, 2009, Sarukhan et al. 2009, 2012). This country-level assessment, built upon the Millennium Ecosystem Assessment conceptual framework, was updated in 2017. The assessment's objective is to provide an organized account of the knowledge about Mexico's natural capital, including its structure, functioning and conservation status, the use of its components and the environmental services it supplies. It also identifies knowledge and policy gaps.

CNM devotes an entire chapter to the current state and trends of the major services supplied by Mexican ecosystems:

- Provision services: Crop production; Livestock production; Fisheries; Aquaculture; Forestry (timber and non-timber products); Water supply;
- Regulation services: Pollination; Control of disease vectors; Erosion control
- Cultural services.

As CNM points out, Mexico's biodiversity is an essential component of the country´s natural capital, at least as important as financial and manufactured capital, but not properly appreciated so far. A proper quantification and valuation of ecosystem services could inform decision making that affect natural resources management.

3.2.2 Review of Ecosystem Services valuation literature

Besides the CNM, other studies on valuation of ecosystem services have been conducted in Mexico, fuelled by an awakened interest in economic instruments for environmental conservation.

A non-exhaustive search yielded a total of 150 studies focusing on this subject matter. An overview table of may be found in Annex C. While a few studies were completed in the 1990s, their number peaked in the 2000s (Fig. 2a), likely triggered by the launch of the Mexican Payment for Ecosystem Services (PES) programme in 2003, then reinforced by the *Millennium Ecosystem Assessment* report in 2005, the CNM in

2006 and *The Economics of Ecosystems and Biodiversity* reports in 2010 (Balvanera et al., 2012; Perevochtchikova, 2014; Perevochtchikova & Oggioni, 2014; Pérez-Verdín et al., 2016; Mkwara, 2017).

The majority of those studies were undertaken by academic or research institutions either by themselves or in association with NGOs, government agencies or consultancy firms (Fig.2b). Mexican government agencies also conducted or commissioned some studies. Most of them focused on a single location, while others had a regional or country-wide scope. Mexico´s PES was included in several international studies on ecosystem services (Fig.2c). About 40% of the 150 studies reviewed was led by academic institutions such as UNAM, Colegio de Posgraduados, Universidad Autónoma Chapingo, INECOL, Universidad de Baja California Sur and CIBNOR. Participating government agencies included the National Forestry Commission (CONAFOR), the National Institute for Ecology (SEMARNAT-INE, currently the National Institute for Ecology and Climate Change, INECC) and the National Commission for Protected Areas (CONANP, in collaboration with the German Agency for International Cooperation, GIZ).

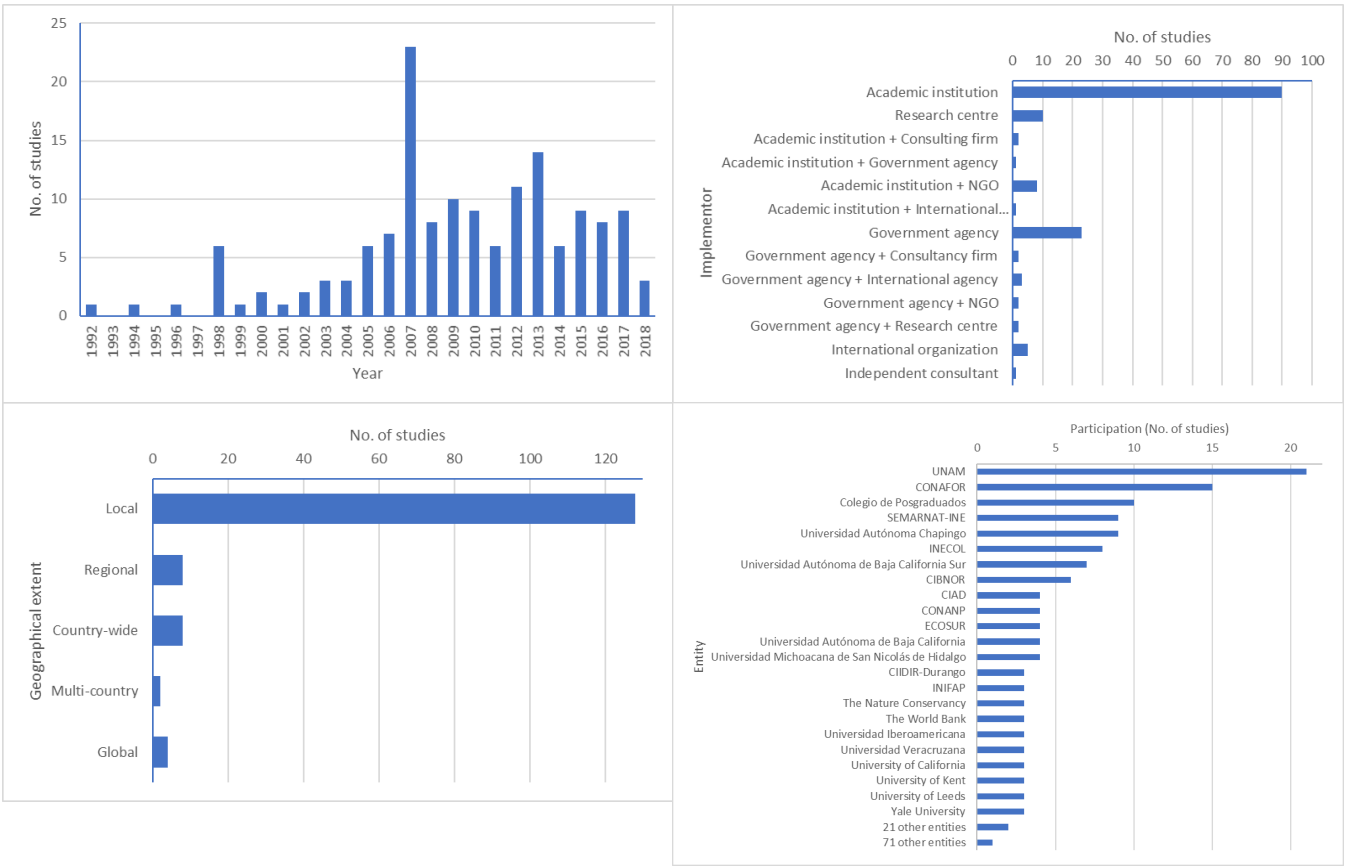

Figure 2. Statistics of the 150 ecosystem services valuation studies examined. a) (upper left) Number of studies published per year; b) (upper right) number of studies published per type of implementer; c) (bottom left) geographical extent of the studies; and d) (bottom right) entities (institutions, agencies or organizations) that participated in the studies ether on their own or in association with others.

As shown in Table 3, provisioning services, particularly food, water and raw materials, such as timber and non-timber forest products, were the services most often included in the 150 studies examined. With respect to regulating services, a focus was placed on the regulation of air quality, climate (through the capture and/or storage of carbon), water flows and water purification. Recreational services derived from ecosystems were also evaluated. *Contingent valuation* was the valuation method that was most

often used, either on its own or in combination with other methods, particularly for the monetary valuation of recreation services and for water supply services. *Direct market pricing* was also often used, particularly for monetizing food and timber provision services. *Benefit transfer* was used to impute monetary values to a range of ecosystem services, in cases where local information, time or budgetary resources were insufficient. A full reference to the type of ecosystem services and valuation methods used in the reviewed studies may be found in Table 3.

Table 3.- Type of ecosystem services and valuation methods used in the 150 ecosystem services valuation studies reviewed.

	Provisioning services						Regulating services								Cultural services					Habitat services				
Valuation method(s)	Food	water	Raw materials	Genetic resources	Medicinal resources	Ornamental resources	Air quality regulation	Climate regulation	Moderation of extreme events	Regulation of water flows	Waste treatment	Erosion prevention	Maintenance of soil fertility	Pollination	Biological control	Aesthetic information	Spiritual experience	Opportunities for recreation	Inspiration for culture	Information for cognitive development	Maintenance of life cycles	Maintenace of genetic diversity	Bundle of services	**Total**	**%**
Avoided Cost							3		1		1				1									6	***2***
Benefit Transfer	4	4	3	1			2	4	1	4	5	1		1	1	2		4				3	2	42	***16***
Choice Experiment																		2				1		3	***1***
Choice Modelling								2															1	3	***1***
Contingent Valuation	3	15	1				1	1		8	3							18	1	1	1	3	8	64	***24***
Direct Market Pricing	23	1	14					11										2			4	2		57	***22***
Hedonic Pricing							1									1		1						3	***1***
Mitigation Cost									1		1													2	***1***
Production Function	2	1																1			1			5	***2***
Productivity Loss	2	2	1				2	1					1											9	***3***
Replacement Cost			1							2	4	1												8	***3***
Travel Cost																		17						17	***6***
Value of Statistical Life							3																	3	***1***
Multiple Valuation Methods	3	12	1		1		2	3		3		2		1				12						40	***15***
Total	37	35	21	1	1	0	14	22	3	17	14	4	1	2	2	3	0	57	1	1	6	9	11	262	100
%	***14***	***13***	***8***	***0***	***0***	***0***	***5***	***8***	***1***	***6***	***5***	***2***	***0***	***1***	***1***	***1***	***0***	***22***	***0***	***0***	***2***	***3***	***4***		

SEEA

Other authors (Pérez-Verdín, 2012; Pérez-Verdín et al., 2016; Lara-Pulido et al., 2018) have also surveyed the ecosystem services valuation studies conducted in Mexico. The results are shown in Annex C.

Scope and coverage

The extensive research on valuation of ecosystem services carried out in Mexico over the last 25 years is related to the build-up of technical capacities. Coverage, however, has been limited and biased. Some areas, such as the Northern half of Mexico, ecosystems such as agroecosystems, shrublands, arid zones, and important ecosystem services such as pollination, medicinal resources, cultural heritage, biofuels, disease regulation, waste processing, non-use benefits of watershed services were relatively neglected (Pérez-Verdín, 2012; Pérez-Verdín et al., 2016; Lara-Pulido et al., 2018). As shown in Table 3, the studies to date have focused on critical services (such as water flows regulation) and on those with high, direct economic impact (such as the provision of food and raw materials, recreation and ecotourism), leaving aside other apparently less appreciated services (Pérez-Verdín et al., 2016).

Design

Several reviewers have also pointed out the lack of coherence in the valuation studies conducted in Mexico. Most of these studies followed a case-study approach, examining a particular service at a given locality, without unnveiling the selection criteria. (Pérez-Verdín et al., 2016). Thus, the studies examined a range of social, economic, environmental, institutional, regulatory, cultural and other aspects using different methodologies and theoretical approaches, according to the specific objectives of each study, but without a common, integrated approach (Perevochtchikova, 2014; Perevochtchikova & Oggioni, 2014). This set of studies hardly add up to a coherent whole, with shared methodologies and comparable accounts, and no generalization can be drawn to inform country-wide environmental policies. (Pérez-Verdín et al., 2016; Lara-Pulido et al., 2018). Finally, there has been little interdisciplinary work, few linkages with the potential users of the studies, and insufficient outreach and dissemination efforts to influence broader audiences.

Technical/methodological issues

Several reviewers have pointed out the inadequate application of valuation methods in ecosystem services studies conducted in Mexico. For example, Pérez-Verdín et al. (2016) found many studies in which the valuation methods were poorly chosen, including the use of non-market methods for the valuation of agricultural/livestock services for which market-based methods might be more appropriate (see Table 1).[6] INECC (2015 a, b) and Lara-Pulido et al (2018) pointed out that several studies valued a bundle of unspecified ecosystem services —rather than a specific service, limiting thus the possibility of comparisons. Many studies evaluated only the service's supply but not the demand for it, which might lead to wrong interpretations of their economic value (Guevara-Sanginés, 2015).
Mkwara (2017) observed that most valuations do not meet the SEEA-EEA requirements. Overall, out of the 98 studies she reviewed, only 15 provisioning, 10 regulating and 1 cultural services valuation studies were found suitable for the SEEA-EEA accounting framework.

3.2.3 Data availability

[6] A serious criticism concerns the improper use of inadequate *contingent valuation* methods, too frequently used in Mexico. (see Table 1). (Pérez-Verdín, 2012, 2016; Guevara-Sanguinés, 2015; Pérez-Verdín et al., 2016; Romo Lozano, 2017).

Various governmental agencies regularly collect, as part of their operation, statistical and geographical data and information which are fully relevant and potentially useable for examining different aspects of ecosystem accounting. However, as those data are often collected for purposes different from ecosystem services accounting, they may need to be reformatted, adapted, reformulated or used as inputs for biophysical models/analyses before their use in a stocks and flows approach. Annex D identifies and lists major data sets directly or potentially relevant or useable —after suitable pre-processing— for examining different aspects of ecosystem services accounting according to SEEA-EEA methodology.

The experience gained through the pilot studies being carried out as part of the NCAVES-Mexico project shows that for country-wide level studies the existing information is very useful, although a number of data gaps still remain, particularly with regard to information on ecosystem condition, and on the supply of ecosystem services, especially for the more complex services such as the hydrological ones.

The CNM assessment pointed out that Mexico's *"…natural capital has not been properly appreciated, partly due to the lack of information and studies to properly quantify and value the services supplied by Mexican ecosystems and thus evaluate the costs, benefits and trade-offs that decisions affecting natural ecosystems entail…"* (CONABIO 2006, 2008a, 2008b, 2009, Sarukhan et al. 2009, 2012, 2017). Some data sets provide valuable information but whose insufficient spatial reference limits their usefulness for ecosystem accounting purposes. Some available data and information lack the temporal recurrence or the spatial resolution necessary for considering specific services at a local level.

3.3 Relevant projects and initiatives

Some projects and initiatives are relevant for ecosystem accounting: EcoValor; BIOFIN; TEEB Mexico; ANCA project.

EcoValorMx

In 2013 the National Commission for Protected Areas (CONANP) launched an initiative whose title "*EcoValorMx"* stands for "Valuation of ecosystem services in Mexican federal protected areas: An innovative tool for financing biodiversity and climate change". This project benefited from financial and technical support from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB for its acronym in German) and the German Agency for International Cooperation (GIZ). *EcoValorMx* ran from 2013 to 2018 and pursued the following objectives (CONANP, 2015):

- Improve and disseminate the knowledge on ecosystem services in Mexico.
- Elevate the positioning of protected areas in Mexico's policy agenda
- Identify and implement revenue-generating mechanisms for protected areas
- Make ecosystem services more visible and adopt measures to ensure the conservation of those services necessary for social welfare.

The main outputs from *EcoValorMx* include pilot valuation studies of services provided by ecosystems in three high-priority protected areas (CONANP-GIZ 2017a, b, c), valuation studies of the contribution of protected areas to productive sectors (including agriculture, forestry and fisheries), and their role in protecting people and their assets against hurricanes. The outputs also include proposals to incorporate the value of ecosystem services into private sector's investment, as well as a variety of outreach materials for different audiences, available at the EcoValorMx's website.

The Economics of Ecosystems & Biodiversity- Mexico Initiative

The TEEB Mexico project was launched in 2014 with the purpose of reducing the pressures on and threats to natural resources of the country by incorporating the value of biodiversity and ecosystem services in economic decision making in the public and private sector. TEEB Mexico also aims at identifying and highlighting economic benefits derived from the conservation and sustainable use of biodiversity and ecosystem services and to evaluate the costs of the loss of biodiversity and ecosystem services for the economy, well-being and social development (http://www.teebweb.org/teeb-mexico/initiative/).

The several long-term goals of TEEB Mexico include the following, particularly relevant for this review:

- Demonstrate the links between biodiversity and ecosystem services and human wellbeing.
- Underline the economic value of ecosystem services and biodiversity for the Mexican economy, social development and wellbeing.
- Integrate biodiversity and ecosystem values in economic, legal and policy instruments.
- Recognize and compensate the benefits provided by biodiversity and ecosystems through market-based mechanisms.

TEEB Mexico intends to achieve these goals by means of biophysical analyses and economic valuation studies, from which recommendations will emerge to improve public policies and fiscal regulations as well as instruments for decision makers and the private sector, while properly considering the vital role of Mexican ecosystems and biodiversity for local and global wellbeing. Based on a consultation among relevant government agencies and international donors, TEEB Mexico identified three priority sectors to be included in initial TEEB analyses: Forests and watersheds, natural resource management and water and wetlands. A project proposal to undertake such studies was submitted to the Global Environmental Facility for consideration.
In 2016, UN-Environment, FAO and the GIZ launched a study on TEEB Agriculture and Food in Mexico, and an additional project called "*Mainstreaming biodiversity into agriculture in Mexico*" was prepared to be carried out from 2017 to 2019, funded by EU.

The Advancing Natural Capital Accounting project (2014-2015).

In 2014 Mexico was chosen, along with together with Bhutan, Chile, Indonesia, Vietnam, Mauritius and South Africa, as one of the pilot countries for the *Advancing Natural Capital Accounting* (ANCA) project launched by UNSD, the UN-Environment TEEB Office and the Secretariat of the CBD, with funds from the Norwegian Agency for Development Cooperation. The ANCA project aimed at reviewing data availability and developing plans for further advancing and testing the UN System of Environmental Economic Accounting – Experimental Ecosystem Accounting (SEEA-EEA) framework in pilot countries. Over the two years of implementation of the ANCA Project in Mexico (2014-2016), INEGI, SEMARNAT, and other key governmental agencies collaborated to identify:

- suppliers and users of environmental-economic information in statistical and geospatial terms;
- the country's environmental policy priorities;
- the relevant stakeholders and the technical capacities to undertake ecosystem accounting in Mexico.

(Bischof & López, 2015)

To support this initiative, an Interinstitutional Technical Group was established, comprising expert representatives from government agencies, academic institutions and international agencies. Technical capacities for compiling Experimental Ecosystem Accounts were developed with support from UNSD.

Steps necessary to advance and test the SEEA-EEA framework in Mexico were outlined, and an initial pilot study for the State of Aguascalientes was completed (INEGI 2015a, b).

A sound foundation for NCA exists in Mexico in terms of data sources, local capacities and a wealth of related studies and projects can act as stepping stones for further work.

4. Policy applications of natural capital accounting in Mexico

While developed economies, particularly European countries, had been using taxation and other economic instruments to address environmental issues since the early 1990s, progress has been slower in developing countries. Since the late 1990s, the Mexican government, as well as a few others in Latin America, undertook efforts to introduce economic instruments to internalize environmental costs in its policy and regulatory framework. New taxes, fees, PES schemes, and some initial attempts to set up a carbon market were considered.

4.1 Taxes and Fees

In 1996, a reform of the main Mexican federal environmental law (LGEEPA, *General Law on Ecological Equilibrium and Environmental Protection*) included provisions for a broader use of economic instruments. Examples included the following (Budedo, 1997; PINE database):

- Water effluent charges, aimed at supporting water treatment programmes and preventing pollutants from being discharged into waterbodies. Effluents exceeding the regulatory limits were subject to a proportional charge..
- Entrance fees in protected areas to finance their conservation.

In 2001, Mexico's executive branch submitted an initiative to the Mexican Congress to reform the Federal Rights Law (Muñoz-Piña, 2002; Giner de los Ríos, 2002). Rights introduced included those related to the non-extractive, recreational use of marine parks, whale-watching, extractive use of wildlife (i. e., hunting) in federal lands, with some differentiation according to the ecosystem type or service.

The Clean Development Mechanism of the Kyoto Protocol represented a foray into the establishment of a carbon market, soon to be curtailed by a slump in the demand. In 2012 Mexico's General Climate Change Law included provisions for the establishment of a carbon tax. A proposal was submitted to the Mexican Congress in 2013 as part of a broader fiscal reform. Congress approved the initiative with some significant changes, including (Cottrell et al., 2016):

- A lower average carbon tax (US$3.7 per ton of CO_2, instead of the proposed US$ 5.7)
- The amount would not tax the full carbon content of fuels but, rather the emissions additional to those stemming from the use of natural gas, exempted from the tax, as was jet fuel.
- The tax could be paid with internationally recognized certificates of emission reductions, at market values. The collapse of the CDM prevented then Mexico from using this interesting link between taxation and carbon markets.

As of 2019, no proper national carbon market has been setup.

Other major federal environmental taxes currently in place in Mexico are:

- Special Excise on Products and Services (IEPS, for its acronym in Spanish) on gasoline and diesel.
- Taxes on new motor vehicles, transferred in 2012 to States jurisdiction, where many of them were derogated.
- Tax on pesticides

More recently, some State or municipal governments launched initiatives to impose environmental taxes targeting specific sectors or activities. For example, in 2017 Mexico's Municipality of Solidaridad, Quintana Roo, implemented a new tax on tourism designed to support the preservation of beaches and ecosystems in Riviera Maya. Revenues -currently 20 Mex pesos per room/ night- are deposited in an environmental trust fund.

In 2017 the Congress of Zacatecas taxed mining activities in the State, a move that was challenged in court by big mining companies.

4.2 Payments for Ecosystem Services schemes

Payment for ecosystem services (PES) schemes stand out among the various mechanisms aimed at introducing ecosystem services concepts into the economic decision-making. Mexico, along with a few Latin American countries, has been trying these schemes over the last two decades (Balvanera et al., 2012; Mokondoko et al., 2016), starting with local levels.
Scolel'te forest carbon project, focused on reforestation and forest management by indigenous communities in the State of Chiapas, was a big success. This is the longest-running ecosystem services project on the voluntary carbon market in the world. It began as a pilot programme in 1994, became fully operational in 1997 and, coordinated by the Mexican NGO Cooperativa AMBIO, it has been running in a self-sustainable way since 2002. The project currently supports 1287 producers and nine community groups, benefitting some 2450 families. It has issued over 518 thousand carbon credits to date, involving nearly 9 thousand ha of land under management.[7]

The second PES initiative in Mexico was the FIDECOAGUA programme established in 2003 in the Municipality of Coatepec, in the State of Veracruz. It aims at ensuring long-term water supply in the region by protecting Coatepec's remaining forests. A dedicated trust fund, "FIDECOAGUA" was established to collect contributions from local government agencies, blended with revenues from a dedicated, small levy on municipal water use. Through FIDECOAGUA, water users reward forest managers for the maintenance of forest cover in the upper hydrological basin (Manson, 2004).

The first country-wide Mexican PES programme was launched in 2003 by the Mexican government through its National Forestry Commission (CONAFOR). The programme was known as Programme for Hydrological Environmental Services (PSAH for its acronym in Spanish) and was meant to provide economic incentives to reduce/avoid deforestation in parts of the country where hydrological problems are linked to deforestation, but where commercial forestry could not outperform agriculture or cattle ranching and where traditional policies (e.g., regulation of land-use change, promotion of sustainable forest management and measures to stop illegal logging) had not been effective (Muñoz-Piña et al. 2008). The PSAH was conceived as a flexible financial tool aimed at ensuring the long-term provision of hydrological services provided by forests. It would also abate poverty in participating rural populations and pave the way for the eventual development of a market for environmental services in Mexico (Pérez-Maqueo et al., 2005). The country-wide coverage and its dual environmental-cum-social purpose have both been persistent features of the programme (Muñoz-Piña et al., 2008).

The PSAH defined hydrological environmental services as those provided by forests which are directly related to aquifer recharge, water quality maintenance, regulation of runoff and sediment loads downstream, regulation of water flows during extreme rainfall events, surface water availability, and flood risks (Pérez-Maqueo et al., 2005). The programme would make direct payments to legal owners of well-preserved forested lands, in natural temperate or tropical forests, in compensation for the hydrological services they provide, determined by the forests' extent and condition. Participating forest owners committed to avoid land changes, conserve forest cover, avoid overgrazing, monitor and fight forest fires, and produce yearly plans to implement improved land management practices over the course of the contract (DOF, 2013). (Pérez-Maqueo et al., 2005; Cortina & Saldaña Espejel, 2014; Alix-García et al., 2018).

[7] Tipper, 2002; http://www.planvivo.org/project-network/scolelte-mexico/

The public-good nature of hydrological services makes it difficult to set a framework for private transactions between the producers and users of hydrological services. Instead, the Federal Rights Law was reformed to earmark a portion of federal revenues from water fees for funding the payments, so as to indirectly link producers with users. CONAFOR has been acting as the only buyer on behalf of water users (Muñoz-Piña et al., 2008).

In principle, the amount to be paid for the supply of an ecosystem service should be based on the economic value of the service involved. As this value is not well known, the amount to be paid by the PSAH was set to reach the maximum forest extent compatible with the budget set by Congress, using the opportunity cost of not deforesting to devote the land to agriculture or livestock ranching as a reference (minimum acceptable payment) (Sanjurjo & Ríos, 2007). The payment was initially set at 300 Mex $ (~15 USD)/ha/yr for temperate or tropical forests, fetching up to 400 Mex $ (~20 USD) in mountain cloud forests (Muñoz-Piña et al., 2008; Mokondoko et al., 2016). Contingent upon compliance with the terms pledged, as assessed by CONAFOR using satellite imagery and field visits, payments were to be made annually for a period of up to 5 years (Cortina & Saldaña Espejel, 2014). In its first year of existence (2003), the PSAH received over 900 applications covering close to 600,000 ha, but only 127 000 ha were accepted due to budgetary limits. In 2004, Congress increased the PSAH's budget by 50% and an additional 180 000 ha entered the programme. Most contracts were placed on forests under collective ownership ("ejidos" and indigenous communities) (Muñoz-Piña et al., 2008).

Operational rules and eligibility criteria of Mexico's PES programme underwent then several adjustments. Payment rates were raised and, more importantly, the programme was expanded to include other key ecosystem services (Perevotchikova & Oggi 2014). In 2004 the programme for carbon capture, biodiversity protection and agro-forestry services (known as PSA-CABSA) was launched. This modality aimed to preserve wildlife by preventing land-use change in critical ecosystems such as tropical forests, mangroves and other hydrophyte vegetation, arid zones and natural grassland. It also allowed for the introduction of improved agroforestry systems and the enhancement of carbon sequestration through forest conservation and reforestation. In 2006, PSAH and PSA-CABSA were merged into a single programme known as Payment for Forest Environmental Services Programme (PSAB, for its acronym in Spanish) comprising four components (hydrological, biodiversity, carbon and agro-forestry services) each with its own operational rules. PSAB became eventually part of a broader forestry programme known as PRONAFOR and the thematic coverage was restricted to hydrological and biodiversity conservation services.

In 2008, in order to increase the funds available and to encourage the direct involvement of beneficiaries of environmental services, the Mexican Congress authorized the participation of State or municipal governments, non-government organizations, private entrepreneurs, and society at large in a third modality of Mexico's PES programme: *Local payment-for-environmental-services mechanisms through concurrent funding*, abbreviated as MLPSA-FC (Cortina & Saldaña Espejel, 2014). MLPSA-FC is, in essence, a local-level version of the main PES programme, whereby partner organizations and CONAFOR set-up a trust fund with equal participation, to fund 10yr-long PES contracts for local forest owners. Several dozen such local PES mechanisms are currently in place.

Mexico's PES programme has been operating for 16 years already. As shown in Table 4, from 2008 to 2017 the programme protected over 5.3 million hectares of strategic forest areas through the payment of almost 9 billion Mexican pesos (approx. 455 million USD), mostly provided by the Mexican government. This makes the Mexican PES programme one of the largest and longest standing in the world (Alix-García et al., 2012; Perevotchikova & Oggi 2014; Caro-Borrero et al., 2015).

Table 4.- Yearly data for forest area coverage and payments made by Mexico's Payment for Environmental Services programme in three modalities: payments for hydrological services, payments for biodiversity conservation services (source: SEMARNAT's BADESIARN) and local mechanisms with concurrent funds (source: CONAFOR, pers. comm., 2018).

	Hydrological services		Biodiversity		MLPSA-FC		
Year	Coverage (ha)	Funds disbursed (Mx pesos)	Coverage (ha)	Funds disbursed (Mx pesos)	Coverage (ha)	Funds disbursed by CONAFOR (Mx pesos)	Funds disbursed by counterpart (Mx pesos)
2008	319,622	130,574,520	137,855	63,598,784	25,982	35,605,052	41,640,395
2009	318,145	263,623,762	181,384	147,059,351	93,565	43,457,114	44,787,895
2010	331,830	421,053,223	176,883	208,790,511	29,800	51,778,534	54,270,738
2011	293,513	543,977,803	170,334	274,019,842	61,775	84,610,169	90,580,469
2012	379,698	679,602,710	178,823	334,039,875	85,347	150,237,453	160,238,485
2013	245,381	562,761,970	222,687	334,653,731	51,469	100,028,825	106,519,389
2014	236,890	599,211,495	159,892	343,728,428	80,751	145,374,987	157,498,520
2015	213,523	529,641,172	205,367	363,585,865	14,952	24,782,272	33,155,505
2016	359,716	534,126,604	356,807	423,160,304	71,812	82,253,712	121,372,590
2017	107,105	306,393,557	127,826	313,936,198	94,562	42,038,954	60,523,348
Total	**2,805,423**	**4,570,966,816**	**1,917,859**	**2,806,572,889**	**610,016**	**760,167,072**	**870,587,334**

The programme is regularly subject to independent evaluations (Universidad Autónoma Chapingo, 2006, 2007; Colegio de Posgraduados, 2005a, b, 2006, 2008; Programa Universitario de Medio Ambiente, 2012; Almeida Leñero et al., 2014; Cortina Segovia & Saldaña Espejel, 2014) including interviews with some stakeholders (i.e., programme managers and administrators, beneficiaries, unsuccessful applicants, local authorities, academic experts). These evaluations detected an enhanced awareness of the value of forest conservation, high levels of satisfaction among most participating forest owners and an improvement in forest conservation. Participants perceive a slight increase in family´s income, an expansion of community participation and technical capacities, as well as a reduction of illegal logging, grazing and forest fires.

The new Federal Administration (2019- 2024) is currently reviewing the PES programme, and its permanence is as yet uncertain in a context of sharp budgetary cuts in the environmental sector. Although the above-mentioned evaluations have generally been quite positive, several authors have pointed at opportunities for improvement. The following issues should be addressed to better target the programme, improve its impacts and make the mechanism sustainable in the long term.

- Targeting. - The issue of basing payments on the actual measurements of ecosystem services that the programme intends to preserve has been repeatedly raised. Despite the name of its specific segments, Mexico's PES programme does not assess nor directly monitor the provision of hydrologic or biodiversity conservation ecosystem services. It rather focuses on the conservation of forest cover or avoided deforestation, as a proxy for the actual services.

- Additionality. - There is evidence that many forested areas accepted in the hydrological services programme are under low risk of deforestation. Arguably, the programme has been paying for some conservation that might have happened anyway.

- Paying a fair amount for the services provided. - A number of review studies have pointed out the need for conducting a more realistic evaluation of opportunity costs, in order to set a fairer level of payment and thus improve the programme effectiveness.

- Recognizing and valuing the multiple services that ecosystems provide. -The need to recognize the multifunctional nature of ecosystems and set a fairer level of payment according to the multiple services that ecosystems supply —rather than isolating one single service and overlooking others— has also been pointed out

- Inadequate monitoring. - The need to better monitor the biophysical (e.g., water quantity and quality, downstream silting, carbon capture, landscape aesthetic value, etc.) as well as the social and economic benefits that the PES programme aims to enhance has also been stressed.

- Permanence of conservation activities after payments end. - Concern has been expressed as to whether the benefits of the Mexican PES programme would continue once payments end.

- Keep environmental and socio-economic objectives separate.- While bundling environmental and social objectives has its merits, some critics have emphasized the need to keep such objectives separate and addressing poverty alleviation also through other specific mechanisms, so as to avoid inadequate land-use practices.

- Financial sustainability. - The long-term cash flow to maintain Mexico's PES programme has been a matter of concern since the earliest reviews.

4.3 Markets for GHG emissions

Art. 94 of the General Law on Climate Change, in force since 2012, allowed for the establishment of a GHG emissions trading system (ETS). In 2016 the Mexican government, in collaboration with the Mexican Stock Exchange and the private company MexiCO2 - Mexican carbon platform, launched a market simulator (no real emissions were traded) aimed at paving the way for an eventual ETS that would bring down the cost of climate change mitigation, as stated in Mexico's National Strategy for Climate Change. The market simulator operated with over 100 of the major GHG emitters in Mexico (electricity facilities, and the oil, cement, steel, chemical, paper and aviation industry), accounting for about two thirds of the country's emissions. The simulation set fictional limits to GHG emissions, whose compliance would have been overseen by a fictitious authority. Based on the simulation results, operation rules and processes for an actual market were designed. This simulation exercise ended in June 2018. In October 2018, the Secretariat of Economy unveiled for public consultation draft regulations for the operation of a pilot programme of a national ETS, with a view to launching its first phase in 2022. As the new federal Administration was inaugurated on the 1st of December 2018, the whole process was put on hold. New climate change policies are still undefined as of October 2019. They will be defined when the sectoral programmes, the new Special Programme of Climate Change and the new National Strategy for Climate Change are published, as mandated by the General Law on Climate Change.

4.4 Monitoring and applications

SCEEM and monitoring the state of natural capital may inform budgeting and help prioritize public policies.

- INEGI, in collaboration with SEMARNAT, established a methodology to account for *green* jobs, *green* companies, and value added they generate for the economy.[8]
- INEGI compiles annually environmental protection expenditure accounts (GPA). These accounts include a breakdown by federal, state and municipal expenditures. GPA´s evolution shows a **decreasing** trend in terms of a percentage of GDP since 2009. The total cost of natural resources

[8] https://www.gob.mx/semarnat/prensa/semarnat-e-inegi-contabilizaran-empleos-verdes

depletion and environmental degradation was more than seven times bigger than GPA as of 2017.

- INEGI was also able to break down GPA to identify its biodiversity component.
- INEGI's SCEEM helped project the costs of environmental degradation and natural resources depletion over the period 2010-2100 under various climate change scenarios (SEMARNAT, 2009), although the actual total costs of climate change impacts might be much bigger.
- Collaboration with CONAMP led to the determination of possible criteria for the selection of protected areas based on a return-on investment approach, using insight and data from ecosystem accounting. These criteria should be compounded with others for defining the establishment of new protected areas.

5. Insights for the project and the international NCA community

5.1 Assessment of institutional and policy context

Mexico has participated actively in the international processes centered upon NCA, such as the development of the SEEA, TEEB projects and, more recently, the IPBES.

As stated before, CONABIO´s efforts to determine Mexico´s Natural Capital (CNM), inspired by the Millennium Ecosystem Assessment conceptual framework, is so far the most comprehensive and influential assessment of Mexican ecosystems and the services they provide. It nevertheless calls for further, in-depth work on the country´s natural capital accounting and valuation of ecosystem services.

- Mexico's biological heritage shows signs of deep anthropogenic impacts that have led to what might be described as an **environmental crisis**. There is urgent need to change the development pathway and stop encouraging productive activities that rely upon an irrational use and overexploitation of biodiversity, as well as a severe degradation of ecosystems and the environmental goods and services they supply.
- On the basis of the best scientific information, it is essential to appreciate and value biodiversity in order to preserve and rationally use the country's ecosystems, as these are the source of environmental goods and services on which the well-being of current and future generations depends.
- The Mexican government should establish concrete policies and goals for the conservation, sustainable use and restoration of the ecosystems, their biodiversity and the environmental services they provide, as spelled out in the National Strategy on Biodiversity.

The assessment has found that the concept of measurement and valuation of natural capital and ecosystem services has made uneven inroads into the country's sectoral policies.

In short, the assessment shows that ecosystem / biodiversity concepts have permeated many Mexican institutions and impressive progress has been made over the past decades in sync with international developments. However, work remains to be done to further mainstream NCA into decision-making at multiple levels of government.[9]

5.2 Assessment on SCEEM, data sources, valuation of ecosystem services and projects

Mexico stands out among developing countries by its early attempts to deal with natural capital accounts, the ones being compiled in 1994 (World Bank, 2012). In this area, it is a recognized leader in the LAC region and is often asked to provide technical assistance to others. The PINE indicator has gained traction and is being used in many important policy documents. It provides significant information for the introduction of environmental concerns into decision-making and the evaluation of the country's progress towards sustainability. There is, however, much room for further improvement of the indicator, both in terms of its scope and its valuation methods.[10]

[9] As part of a regional assessment commissioned by UN-ECLAC, Carvajal (2017) examined the progress made by LAC countries on the compilation of economic-environmental accounts and identified the remaining challenges. He found that the **actual use** of environmental accounts in planning and decision-making is key to sustain demand for this analytical approach.

[10] Rivera & Foladori (2006) reviewed the methods used and results produced by the SCEEM. As they pointed out, while productive activities with significant impact on natural resources are regularly included, the selection of specific elements in the SCEEM is not fully justified. Methods and data sources require more detailed description and SCEEM's results tend to miss out the social dimension of sustainable development.

The assessment refers to an extensive experience and a significant capacity in Mexican institutions, but the big expansion of economic valuation of ecosystems services over the last years has not yet entailed a commensurate impact on decision making (Lara-Pulido et al., 2018).

Large sets of relevant data are available in Mexico that can be used for developing ecosystem accounts. Still, information gaps persist that hinder a full use of this instrument for the review and implementation of policies. The impact of ecosystem services valuation studies on actual decision-making has been quite limited (Lara-Pulido et al; 2018). Data sharing and compilation of results from such studies could help other researchers identify gaps (ecosystems, regions or services) that still need to be addressed and thus design future studies more strategically. It could also be used as a source of reference values for studies using a benefit transfer approach. Even rough estimates of the economic value of services could be used by others as a reference.

Mexico's government is engaged in key international initiatives in the environmental domain, such as SEEA, TEEB, IPBES. There exist good opportunities for complementarity between the various initiatives here reviewed. A better coordination of initiatives supporting the valuation of ecosystem services and natural capital (NCAVES, TEEB-Mexico and IPBES), will deliver results that will help to integrate data/information required for the implementation of the ENBioMex and the 2030 Agenda in Mexico, avoiding duplication of efforts.

In short: a strong foundation exists in Mexico for conducting Natural Capital Accounting, subject to further coordination among current initiatives.

5.3 Assessment of policy applications

Scarcity of economic instruments for environmental protection in Mexico has hindered a broader use of ecosystem accounts to inform policy. Taxes and fees have been set more on administrative, budgetary or political considerations than on a proper valuation of the environmental costs or benefits of targeted activities or services. They reflect, at best, part of the government´s investment in maintenance, conservation and surveillance actions, but do not embody the actual value of the involved natural assets. Ideally, such charges should be based on an economic valuation of the environmental services or assets they intend to protect, and the cost of their degradation, if the resulting revenues are earmarked for preservation and restoration actions (Cortina, 2002).

Despite the success and unique features of Mexico's PES programme, complex issues in its design, operation and performance should be addressed to make the mechanism more effective and sustainable.

Proper evaluations of ecosystem services, benefits and costs, could inform the design and performance of new economic instruments, should detailed information and standardized methods be available.[11]

Having a robust, spatially explicit account of the volume and value of the services being used and their beneficiaries, would help convey a better sense of what is at stake and what the fees/taxes/payments are contributing to. More importantly, such knowledge would raise awareness of the linkage and dependence between ecosystems, ecosystem services and users among the private and corporate sectors and other economic agents that benefit from the use of such services. This might then encourage some users to provide direct payment to service providers or enter joint payment schemes in partnership with the

[11] For example, the rights for the use of common goods such as coral reefs should ideally be based on an estimate of the value they represent for tourism as well as the value of the species inhabiting them and the environmental services (coastal protection, carbon capture, etc.) they provide.

government.[12]

In short: there are significant opportunities to for NCA to inform a wide range of both existing and emerging policies.

5.4 Opportunities for NCA and SEEA

Based on international classifications of ecosystems and ecosystem services, the SEEA-EEA approach provides a structured information system that describes the extent and condition of ecosystems, as well as the ecosystem services they generate in both physical and monetary units. The supply-use structure of the accounts links the ecosystem services provided to their beneficiaries.

Adoption of the SEEA-EEA framework, as explored by the NCAVES-Mexico project, could yield the following benefits:

- The clear articulation of the ecosystem services and unified valuation concepts underlying the SEEA-EEA would address some of the methodological issues repeatedly pointed out in reviews of ecosystem services valuation studies.
- The ecosystem accounts could also prop up economic instruments. For instance, the SEEA-EEA's approach could help the PES programme to better target its operation, encompassing at least the key ecosystem services in each region and improving its monitoring mechanisms, thus making it more effective.
- Its spatially explicit foundation would help link the producers and beneficiaries thus facilitating efforts to develop local-level, accurately targeted, user-financed markets for ecosystem services.
- Its eventual integration with the system of national accounts would help monitor the effectiveness of national and sectoral policies.

Outreach efforts to convey the vital importance and value of ecosystems and the services they supply to decision-makers in key sectors such as fisheries, tourism, energy, infrastructure (ports, communications, etc.) as well as in local governments, would be necessary to integrate these concerns into relevant policies and regulations. Such instruments should be backed-up by sound, policy-relevant information on the flow and value of ecosystem services and assets, so that better-informed decisions can be made duly considering potential trade-offs between economic and environmental considerations.

In summary, broad implementation of a unified conceptual and methodological approach such as the SEEA-EEA, could help strengthen the formulation and monitoring of policies, increasing its coherence.

5.5 Recommendations

<u>Strengthening coordination</u>

There is a need to strengthen the coordination of natural capital accounting efforts in Mexico across the various programs, projects and stakeholders.

[12] This is the intention of the more recent programme of local PES mechanisms through concurrent funds being promoted by CONAFOR, in which some private sector entities are already participating. A recent effort by INECC, in collaboration with Mexico's Universidad Iberoamericana, to carefully value ecosystem services in the watersheds serving the Puerto Vallarta area (a tourist resort in the Pacific coast of Mexico), and to identify the beneficiaries and suppliers to set the basis for a local PES mechanism with concurrent funds is also worth knowing and replicating.

Recommendation 1: Establish a high-level national advisory entity including knowledgeable leaders and representatives of main stakeholders and agencies.

This entity would be tasked with promoting the development of an acceptable roadmap for further implementation of natural capital accounting in Mexico and its mainstreaming in policy-making.

Recommendation 2: Establish a platform to facilitate the community of practice around NCA in Mexico.

The expertise of many researchers and experts that have been working on these themes in Mexico in different academic institutions, NGOs and government agencies could be brought together in the form of a community of practice. Such platform might facilitate exchanging, sharing, comparing or challenging different experiences ideas, methods and results, so as to achieve synergies between current efforts. It may build upon the experience of the current Interinstitutional Technical Working Group set up by INEGI.

Enhancing communications

Given the insufficient exposure of some sectors and local governments to the ecosystem services concepts and their benefits for the decision-making process, it will be essential to communicate their importance particularly among key government agencies and civil society´s entities.

Recommendation 3: Outreach efforts to convey the vital importance and value of ecosystems and their services to decision-makers in sectors such as fisheries, tourism, energy, infrastructure as well as in local governments, are clearly necessary to mainstream these issues into the relevant policies and regulations.

Intermunicipal environmental boards might constitute promising avenues to make ecosystem concepts reach local governments. In some parts of the country (e.g., Jalisco, Yucatán peninsula) local leadership and initiative has led municipal governments to establish intermunicipal environmental boards with the purpose of strengthening their local development and environmental governance, for the benefit of the integrated management and conservation of ecosystems and watersheds. Adoption and dissemination of the SEEA-EEA or other related initiatives (e.g., TEEB, IPBES, etc.) among these entities may be welcome to improve their local decision-making process.

Recommendation 4: Disseminate more widely, particularly among non-technical audiences, the results from valuation studies.

A communication gap exists between academics who carry out studies on ecosystem services and the potential users of their results, be they policy- and decision-makers, natural park administrators, or the public at large (Lithgow et al., 2017). There are significant opportunities for bridging this gap.

A worthy example may be found in CONANP's, EcoValorMx project trying to improve and disseminate the knowledge on ecosystem services in Mexico and make ecosystem services more visible through a variety of documents and outreach materials aimed at different audiences, including decision-makers, CONANP's staff and the public at large (available at the EcoValorMx's website).

Recommendation 5: Compiling and systematizing those studies and making their results available to the public at large in the form of a web-based, searchable, continuously updated database, would help researchers design future studies more strategically and would provide valuable reference values for studies

using a benefit transfer approach.[13]

Results from most valuation studies are difficult to access. Lara-Pulido et al. (2018) are currently building an online tool[14] to search for and record additional studies on economic valuation of ecosystem services in Mexico. Mexico´s National Institute for Ecology and Climate Change (INECC) is also carrying out a similar compilation and review effort.

Stimulate applications of the accounts

Recommendation 6: In order to sustain and mainstream NCA in policymaking, its potential has to be demonstrated by actually using its accounts for concrete purposes.

Linking the accounts' results with economic analyses, deriving SDGs indicators from variables included in environmental-economic accounts, building related dynamic models that may orient decision making, may be practical ways of testing the usefulness of NCA approaches. The NCAVES project includes a workstream that may support this objective.

[13] *Eventually, such a database might become an essential reference for valuation studies in Mexico, similar to the Environmental Valuation Reference Inventory (EVRI) (https://www.evri.ca/en) and the Ecosystem Service Valuation Database (ESVD) (https://www.es-partnership.org; de Groot et al., 2012) at a global level.*

[14] Available at http://52.2.244.41/value

References

1. Alix-Garcia, J., de Janvry, A., Sadoulet, E., Torres, J.M. 2005. An Assessment of Mexico's Payment for Environmental Services Program. Comparative Studies Service, Agricultural and Development Economics Division, United Nations Food and Agriculture Organization.
2. Alix-Garcia, J., de Janvry, A., Sadoulet, E., Torres, J.M. 2009. Lessons Learned from Mexico's Payment for Environmental Services Program. Pp. 163-188 In: L. Lipper et al. (eds.), Payment for Environmental Services in Agricultural Landscapes, Natural Resource Management and Policy. Springer Science + Business Media.
3. Alix-Garcia, J.M., Shapiro, E.N., Sims, K.R.E. 2010. Impacts of payments for ecosystem services on deforestation in Mexico: Preliminary lessons for REDD. Tenure Brief 11. University of Wisconsin, Madison, Wisconsin, USA.
4. Alix-Garcia, J.M., Shapiro, E.N., Sims, K.R.E. 2012a. Forest conservation and slippage: evidence from Mexico's national payments for ecosystems program. Land Economics 88: 613–638
5. Alix-Garcia, J.M., Sims, K.R., Yáñez-Pagans, P., & Shapiro, E.N. 2012b. Two-dimensional evaluation: The environmental and socioeconomic impacts of Mexico' s payments for hydrological services program. Conference Proceedings.
6. Alix-García, J., Aronson, G., Radeloff, V., Ramirez-Reyes, C., Shapiro, E., Sims, K., Yañez-Pagans, P. 2015a. Impacts of Mexico's payments for ecosystem services programme. Impact evaluation report 20. International Initiative for Impact Evaluation, New Delhi.
7. Alix-Garcia, J.M., Sims, K.R.E., Pagans, P. 2015b Only One Tree from Each Seed? Environmental Effectiveness and Poverty Alleviation in Mexico's Payments for Ecosystem Services Program. Economic Policy 7: 1–40
8. Almagro Vázquez, F. 2009. Cuentas económicas y ecológicas y desarrollo sustentable. La experiencia de México. Editorial IPN. Mexico.
9. Almeida Leñero, L., Revollo Fernández, D., Caro Borrero, A., Figueroa, F., Espinosa de la Mora, D.M., Cruz, G., Mazari-Hiriart, M. 2014. El pago por servicios ambientales en México 2010: Una evaluación multidisciplinaria. In: Perevochtchikova, M. (Coord.) Pago por servicios ambientales en México. Un acercamiento para su estudio. El Colegio de México, Ciudad de México.
10. Arlinghaus, J. and K. van Dender 2017. The environmental tax and subsidy reform in Mexico. OECD Taxation Working Papers, No. 31, OECD Publishing, Paris.
11. Arriagada, R., Perrings, C., 2009. Making payments for ecosystem services work. Ecosystem Services Economics Series. UNEP. Nairobi, Kenya
12. Arriagada, R.A., Sills, E.O., Ferraro, P.J., Pattanayak, S.K. 2015. Do payments pay off? Evidence from participation in Costa Rica's PES Program. PLoS ONE 10(7): e0131544
13. Arriagada, R., Villaseñor, A., Rubiano, E., Cotacachi, D., Morrison, J. 2018. Analysing the impacts of PES programmes beyond economic rationale: Perceptions of ecosystem services provision associated to the Mexican case. Ecosystem Services 29:116–127
14. Ávila-Foucat, V.S. 2006. Ecological-economic model for integrated watershed management in Tonameca, Oaxaca, Mexico. Ph.D. thesis. University of York, UK.
15. Ayuntamiento de Guadalajara & Espacios Naturales y Desarrollo Sustentable. 2014. Protección de las barrancas de los ríos Santiago y Verde para la provisión de servicios ambientales para la Zona Metropolitana de Guadalajara, Jalisco. Technical report. 179p.
16. Balvanera, P. et al., 2017. Ecosystem services. In: Walters, M., Scholes, R.J. (Eds.) The GEO handbook on biodiversity observation networks. Springer
17. Balvanera, P. et al. 2012 Ecosystem services research in Latin America: The state of the art. Ecosystem Services 2:56-70.

18. Berger García, M.A. 2015. Effectiveness of payment for environmental services programs in Mexico. Ph.D. dissertation. All Dissertations. Paper 1484. Clemson University. South Carolina, USA
19. Berghöfer, A., Wittich, A., Wittmer, H., Rode, J., Emerton, L., Kosmus, M., van Zyl, H. 2015. Analysis of 19 ecosystem service assessments for different purposes. Insights from practical experience. ValuES Project Report. Helmholtz Zentrum für Umweltforschung (UFZ) GmbH, Leipzig, and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn. Germany. 27pp.
20. Berry, L., Olson, J., Campbell, D. 2003. Assessing the extent, cost and impact of land degradation at the national level: Findings and lessons learned from seven pilot case studies. Commissioned by Global Mechanism with support from the World Bank. 204p.
21. Bischof, J., López, C. 2015. National plan for advancing environmental-economic accounting (NP-AEEA) in Mexico (Draft report). UNSD-System of Environmental Economic Accounting - INEGI. Mexico.
22. Blackman, A., Chandru, S., Domínguez, A., Russell, A. 2012. Health impacts of power-exporting plants in northern Mexico. Energy Policy 44:34–45.
23. Boerema, A., Rebelo, A.J., Bodi, M.B., Esler, K.J., Meire, P. 2016. Are ecosystem services adequately quantified? J. Appl. Ecol. 54:358-370
24. Börner, J., Baylis, K., Corbera, S., Ezzine-de-Blas, D., Honey-Rosés, J., Martin Persson, U., Wunder, S. 2017. The effectiveness of payments for environmental services. World Development 96: 359–374
25. Borrego–Hernández, O., García-Reynoso, J. A., Ojerda-Ramírez, M. M., Suárez-Lastra, M. 2014. Retrospective health impact assessment for ozone pollution in Mexico City from 1991 to 2011. Atmósfera: 27:261–271
26. Bovenberg, A.L. 1999. Green tax reforms and the double dividend: An updated reader's guide. International Tax and Public Finance 6:421–443
27. Braat, L.C. 2018. Five reasons why the Science publication "Assessing nature's contributions to people" (Diaz et al., 2018) would not have been accepted in Ecosystem Services. Ecosystem Services 30: A1-A2.
28. Brauman, K.A., Daily, G.C., Duarte, T.K., Mooney, H.A. 2007. The nature and value of ecosystem services: An overview highlighting hydrologic services. Annu. Rev. Environ. Resourc. 32:67-98.
29. Camacho-Valdez, V., Ruiz-Luna, A., Berlanga-Robles, C.A. 2016. Effects of land use changes on ecosystem services value provided by coastal wetlands: Recent and future landscape scenarios. Coast. Zone Manag. 19:1
30. Camacho-Valdez, V., Ruiz-Luna, A., Ghermandi, A. Berlanga-Robles, C.A., Nunes, P.A.L.D. 2014. Effects of land use changes on the ecosystem service values of coastal wetlands. Environmental Management 54:852–864
31. Camacho-Valdez, V., Ruiz-Luna, A., Ghermandi, A., Nunes, P. D. 2013 Valuation of ecosystem services provided by coastal wetlands in northwest Mexico. Ocean Coast. Manag. 78:1–11.
32. Capodaglio , A.G., Callegari, A. 2018. Can payment for ecosystem services schemes be an alternative solution to achieve sustainable environmental development? A critical comparison of implementation between Europe and China. Resources 7: 40.
33. Caro-Borrero, A., Corbera, E., Neitzel, K.C., Almeida-Leñero, L. 2015. ''We are the city lungs": payments for ecosystem services in the outskirts of Mexico City. Land Use Policy 43:138–148
34. Carvajal, F. 2017. Avances y desafíos de las cuentas económico-ambientales en América Latina y el Caribe. Serie Estudios Estadísticos. CEPAL. Santiago de Chile.
35. Chan, K., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R.K., Hannahs, N., Jax, K., Klain, S.C. et al. 2016. Why protect nature? Rethinking values and the environment. Proc. Natl. Acad. Sci. 113:1462-1465.
36. Colegio de Posgraduados 2005a. Evaluación del programa de pago de servicios ambientales hidrológicos (PSAH). Ejercicio fiscal 2004 (Technical report). Chapingo, México.

37. Colegio de Posgraduados 2005b. Evaluación del programa de pago de servicios ambientales por captura de carbono y los derivados de la biodiversidad y para fomentar el establecimiento y mejoramiento de sistemas agroforestales (PSA-CABSA). Ejercicio fiscal 2004 (Technical report). Chapingo, México.
38. Colegio de Posgraduados 2006. Evaluación del programa de pago de servicios ambientales por captura de carbono y los derivados de la biodiversidad y para fomentar el establecimiento y mejoramiento de sistemas agroforestales (PSA-CABSA). Ejercicio fiscal 2005 (Technical report). Chapingo, México.
39. Colegio de Posgraduados 2008. Evaluación externa de los apoyos de los servicios ambientales. Ejercicio fiscal 2007. (Technical report). Cahpingo, México.
40. CONABIO 1998. La diversidad biológica de México: Estudio de país, 1998. Comisión para el Conocimiento y uso de la Biodiversidad. México
41. CONABIO 2000. Estrategia nacional sobre biodiversidad de México. CONABIO, México, D.F.
42. CONABIO 2006. Capital natural y bienestar social. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México
43. CONABIO 2008a Capital natural de México, vol. I : Conocimiento actual de la biodiversidad. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México
44. CONABIO 2008b Capital natural de México, vol. III : Políticas públicas y perspectivas de sustentabilidad. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México
45. CONABIO 2009. Capital natural de México, vol. II : Estado de conservación y tendencias de cambio. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México
46. CONANP 2015, 2017. Valoración de servicios ecosistémicos: Un enfoque para fortalecer el manejo de las Áreas Naturales Protegidas federales de México. Comisión Nacional de Áreas Naturales Protegidas, Secretaria de Medio Ambiente y Recursos Naturales, México
47. CONANP-GIZ. 2017a. Valoración de los servicios ecosistémicos del Parque Nacional Cabo Pulmo. Proyecto de valoración de servicios ecosistémicos de áreas naturales protegidas federales de México: Una herramienta innovadora para el financiamiento de biodiversidad y cambio climático (EcoValorMX).
48. CONANP-GIZ. 2017b. Valoración de los servicios ecosistémicos del Parque Nacional Arrecifes de Cozumel y del Área de Protección de Flora y Fauna Isla Cozumel. Proyecto de valoración de servicios ecosistémicos de áreas naturales protegidas federales de México: Una herramienta innovadora para el financiamiento de biodiversidad y cambio climático (EcoValorMX).
49. CONANP-GIZ. 2017c. Valoración de los servicios ecosistémicos del Parque Nacional Iztaccíhuatl-Popocatépetl. Proyecto de valoración de servicios ecosistémicos de áreas naturales protegidas federales de México: Una herramienta innovadora para el financiamiento de biodiversidad y cambio climático (EcoValorMX).
50. CONANP-GIZ. 2017d. Las Áreas Naturales Protegidas: Activo estratégico para el sector agrícola en México. EcoValorMX).
51. Corbera, S., González Soberanis, C., Brown, K. 2009. Institutional dimensions of Payments for Ecosystem Services: An analysis of Mexico's carbon forestry programme. Ecological Economics 68: 743-761.
52. Cortina Segovia, S., Saldaña Espejel, A. 2014. Retos de la evaluación del programa de pago por servicios ambientales de la Comisiòn Nacional Forestal. In: Perevochtchikova, M. (Coord.) Pago por servicios ambientales en México. Un acercamiento para su estudio. El Colegio de México, Ciudad de México.
53. Costanza, R. & Kubiszewski, I. 2012. The authorship structure of "ecosystem services" as a transdisciplinary field of scholarship. Ecosystem services 1:16-25.
54. Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. Nature 387:253-260
55. Costanza, R., Daly, H.E. 1992. Natural capital and sustainable development. Conservation Biology 6:37-46
56. Costedoat, S., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Baylis, K., Castillo-Santiago, M.A. 2015. How effective are biodiversity conservation payments in Mexico? PLoS ONE 10(3): e0119881.

57. Costedoat, S. 2017. Assessing the effectiveness of payments for environmental services in improving community-based forest conservation in Chiapas, Mexico. Ph.D. dissertation. Universitat Autònoma de Barcelona. Spain.
58. Cotler, H., López, C.A., Martínez-Trinidad, S. 2011. ¿Cuánto nos cuesta la erosión de suelos? Aproximación a una valoración económica de la pérdida de suelos agrícolas en México. Invest. Ambient. 3:31-43
59. Cottrell, J., Schlegelmilch, K., Runkel, M., Mahler, A. 2016. Environmental tax reform in developing, emerging and transition economies. Studies 93. Deutsches Institut für Entwicklungspolitik. Bonn, Germany.
60. Daily, G.C. (Ed.) 1997. Nature's services: societal dependence on natural ecosystems. Island Press. Washington, D.C. 412p.
61. Daily, G.C. 1999. Developing a scientific basis for managing Earth's life support systems. Cons. Ecol. 3(2).
62. Daily, G.C., Matson, P.A., 2008. Ecosystem Services: from theory to implementation. Proc. Natl. Acad. Sci. 105: 9455–9456
63. Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: time to deliver. Frontiers in Ecology and the Environment 7:21–28
64. Daily, G.C., Söderqvist, T., Aniyar, S., Arrow, K., Dasgupta, P., Ehrlich, P.R., Folke, C., Jansson, AM., Jansson, B-O., Kautsky, N., Levin, S., Lubchenco, J., Mäler, K-G., Simpson, D., Starrett, D., Tilman, D., Walker, B. 2000. The value of nature and the nature of value. Science 289:395-396
65. de Alba, E., Reyes, M.E. 1998. Valoración económica de los recursos biológicos del país. Pp.212-234 In: CONABIO 1998. La diversidad biológica de México: Estudio de país, 1998. Comisión para el Conocimiento y uso de la Biodiversidad. México.
66. de Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C., ten Brink, P., van Beukering, P. 2012. Global estimates of the value of ecosystems and their services in monetary units. Ecosystem services 1:50-61
67. Denham, D. 2017. Community forest owners evaluate a decade of payments for ecosystem services in the Mexican cloud forest: The importance of attention to indigenous sovereignty in conservation. Society & Natural Resources, 30:1064-1079.
68. Diario Oficial de la Federación (DOF) 1997. NORMA Oficial Mexicana NOM-001-ECOL-1996, Que establece los límites máximos permisibles de contaminantes en las descargas de aguas residuales en aguas y bienes nacionales. México
69. Diario Oficial de la Federación (DOF) 2001. Plan Nacional de Desarrollo 2001-2006. México.
70. Diario Oficial de la Federación (DOF) 2007. Plan Nacional de Desarrollo 2007-2012. México.
71. Diario Oficial de la Federación (DOF) 2013. Plan Nacional de Desarrollo 2013-2018. México.
72. Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R.T., Molnár, Z., Hill, R., Chan, K.M.A., Baste, I.A., Brauman, K.A., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P.W., van Oudenhoven, A.P.E., van der Plaat, F., Schröter, M., Lavorel, S., Aumeeruddy-Thomas, Y., Bukvareva, E., Davies, K., Demissew, S., Erpul, G., Failler, P., Guerra, C.A., Hewitt, C.L., Keune, H., Lindley, S., Shirayama, Y. 2018. Assessing nature's contributions to people. Science 359:270-272
73. Emerton, L. 2003. Tropical forest valuation: has it all been a futile exercise? Proceedings of the XII World Forestry Congress 2003. Québec City, Canada.
74. European Climate Exchange, 2008. About ECX. European Climate Exchange. London.
75. Ezzine-de-Blas D, Dutilly C, Lara-Pulido JA, Le Velly G, Guevara-Sanginés A 2016. Payments for environmental services in a policymix: Spatial and temporal articulation in Mexico. PLoS ONE 11 (4): e0152514
76. Ezzine-de-Blas D, Wunder S, Ruiz-Pérez M, Moreno-Sanchez RdP 2016. Global patterns in the implementation of payments for environmental eervices. PLoS ONE 11(3): e0149847

77. Federal Government. 2018. Voluntary National Review for the High-Level Political Forum on Sustainable Development. Basis for a Long-Term Sustainable Development Vision in Mexico. México.
78. Galicia, L., Zarco-Arista, A.E. 2014. International Journal of Biodiversity Science, Ecosystem Services & Management 10:275-288
79. García López, T.: Instrumentos económicos para la protección ambiental en el derecho ambiental mexicano. Sociedad y Ambiente. Año 6, nº 17. Julio-octubre de 2018. Pp. 247-266.
80. Gómez-Baggethun, E., de Groot, R., Lomas, P.L., Montes, C. 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. Ecological Eonomics 69:1209-1218.
81. Grima, N., Singh, S.J., Smetschka, B., Ringhofer, L. 2016. Payment for ecosystem services (PES) in Latin America: Analysisng the performance of 40 case studies. Ecosystem Services 17:24-32
82. Honey-Roses, J., Baylis, K., Ramirez, M.I. 2011. A Spatially explicit estimate of avoided forest loss." Conservation Biology 25: 1032–43.
83. INECC 2015a. Revisión sistemática de los estudios existentes de los bienes y servicios ambientales de los bosques de México. Instituto Nacional de Ecología, México.
84. INECC 2015b. Conceptualización de las metodologías de valoración económica y de la evaluación de los apoyos otorgados por servicios ambientales en materia de bosques y selvas. Instituto Nacional de Ecología, México.
85. INEGI 2007. Sistema de Clasificación Industrial de América del Norte, México - SCIAN 2007. Instituto Nacional de Estadística y Geografía, Mexico.
86. INEGI 2015a. Experimental ecosystem accounting. Study case for Aguascalientes, Mexico. Subdirección de Integración de Cuentas Ambientales, Dirección de Cuentas Satélite, INEGI. México
87. INEGI 2015b. Memoria de cálculo de las Cuentas Experimentales de los Ecosistemas de México. Estudio piloto para el Estado de Aguascalientes. Subdirección de Integración de Cuentas Ambientales, Dirección de Cuentas Satélite, INEGI. México
88. INEGI 2017. Sistema de cuentas nacionales de México. Fuentes y metodologías. Año base 2013. Instituto Nacional de Estadística y Geografía, Mexico.
89. Jack, B.K., Kousky, C., Sims, K.R.E., 2008. Designing payments for ecosystem services: Lessons from previous experience with incentives-based mechanisms. Proc. Natl. Acad. Sci. 105:9465–9470
90. Kosoy, N., Corbera, E. 2010: Payments for ecosystem services as commodity fetishism. Ecological Economics 69:1228-1236.
91. Lara-Pulido, J.A., Guevara-Sanginés, A., Arias Martelo, C. 2018. A meta-analysis of economic valuation of ecosystem services in Mexico. Ecosystem Services 31:126–141
92. Le Velly, G. 2015. The Effectiveness of Payments for Environmental Services in Mexican Community Forests. Economies and finances. Université d'Auvergne - Clermont-Ferrand I, 2015. English. <NNT:2015CLF10473>. <tel-01266824>
93. Ley de Hacienda del Municipio de Solidaridad del Estado de Quintana Roo, Última reforma publicada en el Periódico Oficial del Estado el día 21 de diciembre del 2016
94. Liquete, C., Zuliana, G., Delgado, I., Stips, A., Maes, J. 2013 Assessment of coastal protection as an ecosystem service in Europe. Ecological Indicators 30:205-217
95. Lithgow, D., Martínez, M.L., Silva, R. Geneletti, D., Gallego-Fernández, J.B., Cerdán, C.R., Mendoza, E., Jermain, A. 2017 Ecosystem services to enhance coastal resilience in Mexico: The gap between the perceptions of decision-makers and academics. Journal of Coastal Research, 77(spl):116-126
96. López-Morales, C.A., Mesa-Jurado, M.A. 2017. Valuation of hidden water ecosystem services: The replacement cost of the aquifer system in Central Mexico. Water 9: 571
97. Maes, J., Burkhard, B., Geneletti, D. 2018. Ecosystem services are inclusive and deliver multiple values. A comment on the concept of nature's contributions to people. One Ecosystem 3: e24720.

98. Manson, R.H., 2004. Los servicios hidrológicos y la conservación de los bosques de México. Madera y Bosques 10: 3–20
99. Martínez, M.L., Pérez-Maqueo, O., Vázquez, G., Castillo-Campos, G., García-Franco, J., Mehltreter, K., Equihua, M., Landgrave, R. 2009. Effects of land use change on biodiversity and ecosystem services in tropical montane cloud forests of Mexico. Forest Ecology and Management 258:1856–1863
100. Martínez-Harms, M.J., Balvanera, P. 2012. Methods for mapping ecosystem service supply: a review. International Journal of Biodiversity Science, Ecosystem Services & Management, 8:17-25
101. Martin-Ortega, J., Ojea, E., Roux, C. 2013. Payments for water ecosystem services in Latin America: A literature review and conceptual model. Ecosyst. Serv. 6:122–132.
102. Méndez-Toribio, M., Martínez-Garza, C., Ceccon, E., Guariguata, M.R. 2018. La restauración de ecosistemas terrestres en México. CIFOR, Documentos Ocasionales No.185. Bogor, Indonesia.
103. Millennium Ecosystem Assessment (MEA) 2003. Ecosystems and human well-being: A framework for assessment. Island Press, London.
104. Mkwara, L. 2017. Stocktaking assessment of valuation and biophysical studies of ecosystem services in Mexico. 71p.
105. Mokondoko, P., Manson, R.H., Pérez-Maqueo, O. 2016. Assessing the service of water quality regulation by quantifying the effects of land use on water quality and public health in central Veracruz, Mexico. Ecosystem Services 22:161-173.
106. Mokondoko, P., Manson, R.H., Ricketts, T.H., Geissert, D. 2018. Spatial analysis of ecosystem service relationships to improve targeting of payments for hydrological services. PLoS ONE 13: e0192560.
107. Mooney, H., Ehrlich, P. 1997. Ecosystem services: a fragmentary history. In: Daily, G.C. (Ed.), Nature's Services. Island Press, Washington, DC, pp. 11–19.
108. Muñoz Piña, C., Guevara, A., Bulás, J.M., Torres, J.M., Braña, J. 2006. Pagar por los servicios hidrológicos del bosque en México. In: Pagiola, S., Landell-Mills, N., Bishop, J. (Eds.), Los mecanismos basados en el mercado para la conservación y el desarollo. Instituto Nacional de Ecología, Mexico City, Mexico
109. Muñoz Piña, C., Guevara, A., Torres, J.M., Braña, J. 2008. Paying for the hydrological services of Mexico's forests: analysis, negotiations and results. Ecological Economics 65: 725–736.
110. Muñoz-Piña, C. 2010. Measuring the REDD effect of the payment for hydrological environmental services program in Mexico (PSAH). Workshop on enhancing cost-effectiveness of payment for ecosystem services. Organization for Economic Co-operation and Development, Paris, France
111. Nelson, E., Mendoza, G., Regetz, J., Polasky, S., Tallis, H., Cameron, D.R., Chan, K. MA., Daily, G.C., Goldstein, J., Kareiva, P.M., Lonsdorf, E., Naidoo, R., Ricketts, T.H., Shaw, M.R. 2009. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. Front Ecol Environ 7: 4–11
112. Nelson, E.J., Daily, G.C. 2010. Modelling ecosystem services in terrestrial systems. Biology Reports 2:53
113. OECD. 2010a. Taxation, innovation and the environment. OECD Green Growth Strategy. Paris, France.
114. OECD. 2010b. Paying for biodiversity. Enhancing the cost-effectiveness of payments for ecosystem services. OECD. Paris, France.
115. OECD 2018. Taxing energy use 2018: Companion to the taxing energy use database. OECD Publishing, Paris.
116. Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R.T., Dessane, E.B., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S.M., Wittmer, H., Adlan, A., Ahn, SE., Al-Hafedh, Y.S., Amankwah, E., Asah, E.T., Berry, P., Bilgin, A., Breslow, S.J., Bullock, C., Cáceres, D., Daly-Hassen, H., Figueroa, E., Golden, C.D., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P.H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B.B., van den Belt, M., Verma, M., Wickson, F., Yagi, N. 2017. Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability 26–27: 7-16

117. Peñuela Arévalo, L.A. 2014. El agua subterránea en el estudio de servicios ambientales. In: Perevochtchikova, M. (Coord.) Pago por servicios ambientales en México. Un acercamiento para su estudio. El Colegio de México, Ciudad de México
118. Perevochtchikova, M. 2014. Aproximación teórico-conceptual a los estudios de servicios ecosistémicos, ambientales y esquemas de compensación. In: Perevochtchikova, M. (Coord.) Pago por servicios ambientales en México. Un acercamiento para su estudio. El Colegio de México, Ciudad de México.
119. Perevochtchikova, M., Ochoa Tamayo, A.M. 2012. Avances y limitantes del programa de pago por servicios ambientales hidrológicos en México, 2003 – 2009. Rev. mex. de cienc. forestales 3:89-112
120. Perevochtchikova, M. and J. Oggioni 2014. Global and Mexican analytical review of the state of the art on ecosystem and environmental services: A geographical approach. Investigaciones Geográficas, Boletín, núm. 85, Instituto de Geografía, UNAM, México, pp. 47-65.
121. Pérez Verdín, G., Sanjurjo-Rivera, E., Hernández-Díaz, J.C., Hernández-Trejo, V., Márquez-Linares, M.A. 2016 Economic valuation of ecosystem services in Mexico: Current status and trends. Ecosystem services 21:6-19
122. Perez-Verdin, G., Navar-Chaidez, J.J., Kim, Y-S, Silva-Flores, R. 2012. Economic valuation of watershed services for sustainable forest management: Insights from Mexico. Pp.259-274 In: Diez, J.J., García, J.M. (Eds.) Sustainable Forest Management. Current research. IntechOpen, DOI: 10.5772/45839.
123. Presidencia de la República. 2018. Estrategia nacional para la puesta en marcha de la agenda 2030. México.
124. Programa Universitario de Medio Ambiente. 2012. Evaluación complementaria del ejercicio de los Programas Pago por Servicios Ambientales Hidrológicos S-110 y Pago por Servicios Ambientales derivados de la Biodiversidad S-136. Ejercicio fiscal 2010. Informe Final. Technical report. Mexico City, Mexico.
125. Ramirez-Reyes, C., Sims, K. R.E., Potapov, P., Radeloff, V. C. 2018. Payments for ecosystem services in Mexico reduce forest fragmentation. Ecological Applications. doi: 10.1002/eap.1753
126. Rivera, P., Foladori, G. 2006. Reflexiones sobe la contabilidad ambiental en México. Economía, Sociedad y Territorio VI (21):177-217
127. Romo-Lozano, J. L., López-Upton, J., Vargas-Hernández, J. J., Ávila-Angulo, M. L. 2017. Economic valuation of the forest biodiversity in Mexico, a review. Revista Chapingo Serie Ciencias Forestales y del Ambiente 23:75-90.
128. Saavedra-Díaz, Z.M., Perevochtchikova, M. 2017 Evaluación ambiental integrada de áreas inscritas en el programa federal de pago por servicios ambientales hidrológicos. Caso de estudio: Ajusco, México. Investigaciones Geográficas 93. DOI: dx.doi.org/10.14350/rig.56437
129. SAGARPA 2016. Estrategia de integración para la conservación y el uso sustentable de la biodiversidad en el sector agrícola (2016-2022). Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, México.
130. SAGARPA-CONAPESCA-INAPESCA 106. Estrategia de integración para la conservación y el uso sustentable de la biodiversidad. Sector pesquero y acuícola (2016-2022). Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, Comisión Nacional de Acuacultura y Pesca, Instituto Nacional de Pesca, México.
131. Salles, J.M. 2011. Valuing biodiversity and ecosystem services: Why put economic values on Nature? C. R. Biologies 334:469–482
132. Sanjurjo Rivera, E., Islas-Cortés, I. 2007. Las experiencias del Instituto Nacional de Ecología en la valoración económica de los ecosistemas para la toma de decisiones. Gaceta Ecológica Número especial 84-85:93-105
133. Sarukhán J., Koleff, P., Carabias, J., Soberón, J., Dirzo, R., Llorente-Busquets, J., Halffter, G., González, R., March, I., Mohar, A., Anta, S., de la Maza, J., Pisanty, I., Urquiza-Haas, T., Ruiz González, S. P., García Méndez, G. 2017. Capital Natural de México Síntesis: Evaluación del conocimiento y tendencias de cambio,

perspectivas de sustentabilidad, capacidades humanas e institucionales. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México.

134. Sarukhán, J., Carabias, J., Koleff, P., Urquiza-Haas, T. 2012. Capital natural de México: Acciones estratégicas para su valoración, preservación y recuperación. CONABIO, México
135. Sarukhán, J., Koleff, P., Carabias, J., Soberón, J., Dirzo, R., Llorente-Busquets, J., Halffter, G., González, R., March, I., Mohar, A., Anta, S., de la Maza, J., Pisanty, I., Urquiza Haas, T., Ruiz González, S.P., García Méndez, G. 2017. Capital natural de México. Síntesis: evaluación del conocimiento y tendencias de cambio, perspectivas de sustentabilidad, capacidades humanas e institucionales. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México.
136. Sattler, C., Trampnau, S., Schomers, S., Meyer, C., Matzdorf, B. 2013. Multi-classification of payments for ecosystem services: How do classification characteristics relate to overall PES success? Ecosyst. Serv. 6:31–45.
137. Schnitker, A., Burnett, J.W. 2018. Evaluating the economic value of carbon sequestration in a community-owned and managed forest of rural central Mexico. Manuscript.
138. Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R., Opdam, P. 2014. Ecosystem services as a contested concept: A synthesis of critique and counter-arguments. Conserv. Lett.7: 514–523.
139. SECTUR 2016. Estrategia de integración para la conservación y el uso sustentable de la biodiversidad. Sector turístico (2016-2022). Secretaría de Turismo, México.
140. SEMARNAT. 2009 Estimaciones del impacto del cambio climático, desde el Sistema de Cuentas Económicas y Ecológicas de México. 2010-2100. México
141. SEMARNAT-CONAFOR. 2016. Estrategia de integración para la conservación y el usos sustentable de la biodiversidad. Sector forestal (2016-2022). Secretearía de Medio Ambiente y Recursos Naturales – Comisión Nacional Forestal, México.
142. Seppelt, R., Dormann, C.F., Eppink, F.V., Lautenbach, S., Schmidt, S. 2011 A quantitative review of ecosystem service studies: Approaches, shortcomings and the road ahead. J. Appl. Ecol. 48:630-636.
143. Shapiro-Garza, E. 2013. Contesting the market-based nature of Mexico's national payments for ecosystem services programs: Four sites of articulation and hybridization. Geoforum 46: 5-15.
144. Simpson, R.D. 2011. The "Ecosystem service framework": A critical assessment. Ecosystem Service Economics. Working Paper Series. Paper No.5. Division of Environmental Policy Implementation. UNEP. Nairobi, Kenya.
145. Sims, K.R.E., Alix-Garcia, J.M., 2017. Parks versus PES: evaluating direct and incentive-based land conservation in Mexico. J. Environ. Econ. Manage. 86, 8–28.
146. Stavins, R.N., 1998. What can we learn from the Grand Policy Experiment? Lessons from SO2 allowance trading. Journal of economic perspectives 12: 69–88.
147. Tallis, H., Kareiva, P., Marvier, M., Chang, A. 2008. An ecosystem services framework to support both practical conservation and economic development. Proceedings of the National Academy of Science 105: 9457-9464
148. TEEB 2010. The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations. Earthscan, London and Washington.
149. Tipper, R. 2002. Helping Indigenous Farmers to Participate in the International Market for Carbon Services: The Case of Scolel Te. In: Pagiola, S., Bishop, J., Landell-Mills, N. (Eds.), Selling Forest Environmental Services. Market-based Mechanisms for Conservation and Development. Earthscan, London
150. Turnhout, E., Waterton, C., Neves, K., Buizer, M. 2013. Rethinking biodiversity: from goods and services to "living with". Conserv. Lett., 6: 154-161
151. United Nations 1993. Handbook of National Accounting: Integrated environmental and economic accounting. United Nations publication, Series F, No.61. United Nations.

152. United Nations 2003. Handbook of National Accounting: Integrated environmental and economic accounting 2003. United Nations publication, Series F, No.61, Rev.1. United Nations.
153. United Nations 2014a. System of Environmental-Economic Accounting 2012—Central Framework. United Nations publication, Series F, No.109. United Nations
154. United Nations 2014b. System of Environmental-Economic Accounting 2012—Experimental Ecosystem Accounting. United Nations publication, Series F, No.112. United Nations
155. United Nations. 1992. Agenda 21. United Nations Conference on Environment & Development Rio de Janeiro, Brazil, 3 - 14 June 1992.
156. United Nations. 1998. Kyoto Protocol to the United Nations Framework Convention on Climate Change. United Nations.
157. United Nations. 2000. Integrated Environmental and Economic Accounting. An Operational Manual. Studies in Methods. Series F, No.78. New York
158. Universidad Autónoma Chapingo. 2006. Evaluación externa del programa de pago por servicios ambientales hidrológicos. Ejercicio Fiscal 2005. (Tehcnical report) Chapingo, México.
159. Universidad Autónoma Chapingo. 2007. Evaluación externa de los Apoyos de Pago para Desarrollar el Mercado de Servicios Ambientales por Captura de Carbono y los Derivados de la Biodiversidad y para Fomentar el Establecimiento y Mejora de Sistemas Agroforestales (PSA-CABSA). Ejercicio Fiscal 2006. (Technical report) Chapingo, México.
160. Westman, W., 1977. How much are nature's services worth? Science 197, 960–964.
161. World Bank 1991. Integrated environmental and economic accounting: A case study for Mexico. Environment Working Paper No. 50. The World Bank
162. Patil, P.G. 2012. Moving beyond GDP: How to factor natural capital into economic decision making. Washington, DC. World Bank
163. World Commission on Environment and Development 1987. Our Common Future. Annex to United Nations Document A/42/427- Development and International Cooperation: Environment.
164. Wright, W.C.C., Eppink, F.V., Greenhalgh, S. 2017. Are ecosystem service studies presenting the right information for decision making? Ecosystem services 25: 128-139
165. Wunder, S., Engel, S., Pagiola, S. 2008. Taking stock: A comparative analysis of Payments for Environmental Services Programs in Developed and Developing Countries. Ecological Economics 65:834-852

ANNEXES

Annex A : State level programmes

Table 5 .- Environmental themes addressed —and the priority level attached to them— by different State-level government programmes. Themes are regarded as top priorities when the government plan includes dedicated policies (shown in **boldface**) to address them; else, they are either included as part of policies (shown in italics) meant to address other higher-priority issues (e.g. economic development) or not addressed at all (empty cells).

State/government programme	Use of natural resources, environmental degradation	Ecosystems	Biodiversity	Natural capital & Environmental or ecosystem services
Aguascalientes: Plan estatal de desarrollo 2016-2022	Policy axis IV. Competitive, diversified and prosperous Aguascalientes. Policy axis V. Responsible, sustainable and clean Aguascalientes			
Baja California: Plan estatal de desarrollo 2014-2019	Policy axis 3. Sustainable economic development.			
Baja California Sur: Plan estatal de desarrollo 2015-2021	Policy axis IV. Life quality Policy axis II. Economic diversification.	Policy axis IV. Life quality		
Campeche: Plan estatal de desarrollo 2015-2021	Policy axis Taking advantage of wealth Policy axis Economic strength	Policy axis Taking advantage of wealth		Policy axis Taking advantage of wealth Policy axis Economic strength
Chiapas: Plan estatal de desarrollo 2013-2018	**Policy axis Sustainable Chiapas**			
Chihuahua: Plan estatal de desarrollo 2017-2021	Policy axis 2. Economy, innovation, sustainable development and regional equilibrium Policy axis 3. Infrastructure, urban development and environment			
Programa General de Desarrollo del Distrito Federal 2013-2018	**Crosscutting axis. Sustainability** **Strategic policy axis 3. Sustainable economic development**			
Coahuila: Plan estatal de desarrollo 2017-2023	Policy axis 3. Sustainable economic development			
Colima: Plan estatal de desarrollo 2016-2021	**Cross-cutting policy axis Sustainable Colima**		**Cross-cutting policy axis Sustainable Colima**	
Durango: Plan estatal de desarrollo 2016-2022	Policy axis 4. Equitable development		Policy axis 4. Equitable development	
Plan de desarrollo del Estado de México 2017-2023	**Territorial pillar An orderly, sustainable and resilient Estado de Mexico**			
Guanajuato: Plan estatal de desarrollo al 2040	**Policy priority 3. Environment and territory**		**Policy priority 3. Environment and territory**	
Guerrero: Plan estatal de desarrollo 2016-2021				
Hidalgo: Plan estatal de desarrollo 2016-2022	**Policy axis 5. Hidalgo with sustainable development**		**Policy axis 5. Hidalgo with sustainable development**	
Jalisco: Plan estatal de desarrollo 2013-2033	**Policy axis Environment and sustainable living**			
Plan de desarrollo integral del Estado de Michoacán 2015-2021	**Crosscutting policy: Environmental sustainability, resilience and urban prosperity**		**Crosscutting policy: Environmental sustainability, resilience and urban prosperity**	

Morelos: Plan estatal de desarrollo 2013-2018	**Policy axis 4. A green, sustainable Morelos**			
Plan estatal de desarrollo del Estado de Nayarit: 2017-2021	**Policy axis 7. Conservation and sustainable use of natural resources Policy axis 5. Sustainable territorial development**	**Policy axis 7. Conservation and sustainable use of natural resources**		**Policy axis 5. Sustainable territorial development**
Nuevo León: Plan estatal de desarrollo 2016-2021	Policy axis Sustainable development			
Oaxaca: Plan estatal de desarrollo 2016-2022	**Policy axis V. A sustainable Oaxaca Policy axis IV. A productive, innovative Oaxaca**		**Policy axis V. A sustainable Oaxaca**	
Plan estatal de desarrollo Puebla 2017-2018	**Policy axis Sustainability and environment**			
Plan estatal de desarrollo Querétaro 2016-2021	Policy axis A prosperous Querétaro			Policy axis A prosperous Querétaro
Quintana Roo: Plan estatal de desarrollo 2016-2022	**Policy axis 5. Orderly growth with environmental sustainability** Policy axis 1. Economic development and diversification	**Policy axis 5. Orderly growth with environmental sustainability**		
San Luis Potosí: Plan estatal de desarrollo 2015-2021	**Policy axis A sustainable San Luis**			
Sinaloa: Plan estatal de desarrollo 2017-2021	Policy axis III. Sustainable development and infrastructure			
Sonora: Plan estatal de desarrollo 2016-2021	Policy axis "A government that promotes infrastructure for high life quality and sustainable competitiveness"		Policy axis "A government that promotes infrastructure for high life quality and sustainable competitiveness"	
Tabasco: Plan estatal de desarrollo 2013-2018	**Policy axis Environmental protection, sustainable use of natural resources and energy Policy axis Land-use planning and infrastructure for balanced development**		**Policy axis Environmental protection, sustainable use of natural resources and energy**	
Tamaulipas: Plan estatal de desarrollo 2016-2022	Policy axis Sustainable economic development		Policy axis Sustainable economic development	
Tlaxcala: Plan estatal de desarrollo	Policy axis Regional integration			
Veracruz: Plan veracruzano de desarrollo 2016-2018	**Policy axis "the territorial expression of progress" Policy axis "restructuring productive primary sector activities in consonance with environmental conservation"**			**Policy axis "restructuring productive primary sector activities in consonance with environmental conservation"**
Yucatán: Plan estatal de desarrollo 2016-2022	Policy axis A Yucatan with an orderly growth			
Zacatecas: Plan estatal de desarrollo 2017-2021	**Policy axis 4. Environment and territorial development**			

Annex B: National biodiversity strategy

Table 6.- Strategic objectives, lines of action and actions proposed in the National Strategy on Biodiversity that specifically demand, for their implementation, the valuation of natural capital and ecosystem services; the Aichi target that each strategic objective responds to is also shown.

Strategic objective	Line of action	Action	Intervention(s) proposed
1.- By 2030, knowledge and valuation of biodiversity and ecosystem services have increased and interdisciplinary scientific research —rescuing and integrating traditional knowledge and involving society— has enhanced in order to contribute to a culture of appreciation of biodiversity, the sustainable development of the country and better-informed decisions to guarantee its conservation, recovery and sustainable use, in the face of global change. 	1.1 Generation, documentation and systematization of knowledge	1.1.1. Produce up-to-date information on the conservation status and functioning of ecosystems	• Deepen the knowledge about the role of the ecosystems structure and function in the supply of environmental services. • Understand the role played by different functional groups in the structure, dynamics and functioning of ecosystems and the provision of environmental services
		1.1.2. Promote and conduct scientific research to detect and reverse significant changes in ecosystems caused by anthropogenic factors and natural disturbances, and identify the consequences for their functioning.	• Conduct studies at different scales on changes in the structure and composition of biological communities caused by natural disturbances or anthropogenic pressures and threats, as well as on the relationship between these changes and their resistance, resilience, and capacity to provide environmental services.
		1.1.3. Conduct studies on the ecological, economic and sociocultural valuation of ecosystem services	• Develop and promote interdisciplinary research on the valuation of ecosystem services, including those lacking a market value. • Promote studies on the valuation of well-preserved ecosystems and to estimate the biological, economic and social losses cause by their degradation and the recovery costs. • Estimate the economic and social costs of environmental damage, in order to promote its integration into Mexico's System of National Accounts.
	1.4 Develop tools for access to information	1.4.2. Consolidate institutional systems of statistical and geographic information with data on the conservation status of biodiversity and ecosystem services, and the magnitude of pressure factors affecting them.	
		1.4.5. Develop and strengthen monitoring systems for the integrated management of ecosystems	• Develop indicators to monitor changes in ecosystem services, including economic valuations
2.- By 2030, various mechanisms for the conservation and restoration of biodiversity and of the ecosystem services it provides, as well as cross-cutting public policies for sustainable development with well-being for the population and future generations, have been consolidated.	2.1. In situ conservation	2.1.5. Develop, strengthen and implement financial and economic mechanisms and instruments for the conservation and sustainable use of ecosystems and their services	• Consider the different approaches to the valuation of environmental services in the development and implementation of mechanisms and instruments • Create incentives that guarantee the proper compensation of the owners of areas providing ecosystem services, by those who use or have concessions and receive the benefits of these.

			• Expand, consolidate and articulate existing financial and economic mechanisms and instruments • Promote the development of voluntary mechanisms of payment for environmental services and ensure their articulation with other PES programs (e.g., REDD +). • Include payment schemes that take into account the environmental and social externalities and safeguards of development projects and agricultural production systems. Develop compensation schemes for conservation and restoration activities.
		2.1.14. Promote and adapt traditional knowledge and successful traditional practices that contribute to the conservation of biodiversity	• Internalize the values of biodiversity and ecosystems in rural and urban communities on order to encourage their conservation
	2.3. Restoration of degraded ecosystems	2.3.1. Design, develop, implement and consolidate a national policy for environmental restoration that, using an interdisciplinary, integral, intersectoral, and long-term territorial approach encourages the integrated management of ecosystems and watersheds for its sustainable use and conservation.	• Ensure that environmental compensation schemes supported by public and private programmes include the real cost of degradation and restoration to avoid the conversion of ecosystems
		2.3.2. Implement, expand and strengthen the actions of rehabilitation and restoration of terrestrial ecosystems of according to the biological importance and deterioration condition to achieve the restoration of services ecosystems they provide	• Create and consolidate criteria and methods that consider the restoration of ecosystem integrity and take into account physical, biological, economic, social and gender aspects to support the implementation of actions for the restoration and rehabilitation of terrestrial ecosystems
		2.3.3. Implement, expand and strengthen the actions of rehabilitation and restoration of coastal ecosystems, insular, riparian, continental and marine aquatic according to the biological importance and deterioration condition for achieve the restoration of the ecosystem services they provide.	• Develop and promote economic tools and incentives that support community participation in the restoration of key coastal and marine ecosystems for the environmental services they provide at the local or regional level.
3.- By 2030, users of biodiversity in the public, private and social sectors have the capacities and opportunities to make a sustainable, diversified use of biodiversity, through effective management schemes. Products and services obtained have added value and are incorporated into markets with a focus on permanence, stability and long-term functionality, ensuring	3.2. Development, strengthening and diversification of productive value chains in the agricultural, forestry, fisheries and aquaculture sectors	3.2.2. Incorporate the value of ecosystem services into productive value chains	• Conduct studies of the main value chains to identify and value the ecosystem services involved in production processes. • Conduct specific studies on the importance and status of pollinators, and other critical species, in the ecological processes related to productive chains

that the distribution of derived benefits is increasingly fair and equitable. 		3.2.8. Develop compensation schemes for different environmental services that generate economic welfare effective to the population that directly guards biodiversity	• Evaluate the potential establishment of payment for environmental services schemes in areas devoted to conservation. • Create flexible compensation schemes for environmental services that guarantee the equitable distribution of benefits between men and women as well as their long-term sustainability
4. By 2030, pressure factors on biodiversity have been prevented, reduced, controlled and reversed through the harmonization and application of cross-cutting public policies; institutional and financial mechanisms and instruments for conservation; and an inclusive and effective participation of society 	4.2. Prevention, regulation and control to prevent overexploitation of species	4.2.5. Promote the evaluation of the effects of overexploitation of biodiversity in the ecological, social and economic contexts	Conduct comprehensive, interdisciplinary studies with a gender perspective to understand the environmental, social, economic and cultural impacts of the unsustainable use of natural resources and include the results into decision-making
	4.6. Reduce the vulnerability of biodiversity to climate change	4.6.2 Implement compensation schemes for mitigation and adaptation to the effects of climate change	• Consider the existing mechanisms of REDD+, PES as well as productive alternatives, guaranteeing the fair and equitable distribution of benefits between women and men regardless the land ownership. • Conduct ecosystem services economic valuation studies, including the cost of non-action in terms of mitigation and adaptation to climate change
	4.7. Orderly use of the territory and sustainable urban development	4.7.1. Design and implement sustainable territorial development strategies suitable for megacities, cities intermediate, small and new human settlements and their associated infrastructure	• Promote land use planning with a dynamic approach at different scales and environments (cities in coastal, mountainous, or arid areas, etc.), including biodiversity conservation and ecosystem services as a central criterion. • Fortify and promote citizen and mixed (civil society-government) initiatives for the maintenance of environmental services provided by areas in and around urban and peri-urban areas, strengthening the participation of women in these initiatives. • Promote and conserve urban forests, parks and natural green areas to conserve biodiversity and regulation and support environmental services, as well as provision and cultural services, including temperature regulation. • Seek the redesign of cities based on environmental criteria and the conservation of biodiversity and ecosystem services, including eco-technologies such as rainwater harvesting, green roofs and walls, efficient use of energy, recovery of areas green, reuse and treatment of domestic and industrial water, as well as the proper management of urban solid waste.
		4.7.2. Promote the efficient and sustainable use of inputs and services in cities	• Internalize the costs of restoring forest ecosystems around urban areas into water bills. • Have in place a scheme for the sustainable use of provision services that minimizes the impacts of production processes on local, surrounding and distant ecosystems, that promotes the development, dissemination and use of ecotechnologies

		4.7.6. Include criteria for biodiversity conservation in infrastructure construction works	• Include clear criteria and verifiable technical information in Environmental Impact to Assessments in order to avoid, reduce and mitigate impacts on the environment, biodiversity and ecosystem services caused by the development of infrastructure.

Annex C: Valuation studies

In the earliest of such reviews, Sanjurjo-Rivera & Islas-Cortés (2007) looked at the reasons that prompt the valuation of ecosystem services. These include: Informing the determination of fines and compensation fees for environmental damages, entry fees to natural parks, or payments for environmental services schemes; assessing the cost-benefit and feasibility of restoration projects; evaluating the environmental impact of development projects; supporting or justifying budgetary requests/allocations; appraising the conservation of individual species; or simply because ecosystem service valuation "is important for environmental policy". They conclude that economic valuation of ecosystem services does indeed help orienting decision-making but must be used with caution: As it is virtually impossible to estimate the total value of an ecosystem or service, it cannot be the only criterion for decision.

Perez-Verdin et al., (2012) reviewed the studies aimed at estimating the value of watershed services by means of non-market valuation techniques. They could find only 13 case studies cases of this type, most of them conducted in high elevation areas (over 1 000 meters above sea level), an indication of the relevance of highland watersheds as a source of environmental services, and the need to protect them. Services most commonly examined in these studies included wildlife habitat preservation, soil retention, recreation, water supply (for human consumption or irrigation purposes), fishing, and hunting. The authors concluded that, due to their non-exclusive, non-rival nature, watershed services need to be valued by means of various different approaches. Valuing them in terms only of opportunity costs overlooks part of their total economic value, particularly the non-use value. Further efforts are therefore necessary to understand the use and non-use values of watershed services, disseminate the results of pilot projects, and incorporate all interested sectors of society. Participation of various stakeholders, including government agencies, other institutions and landowners, in these studies can help identify critical or priority watersheds for cities, private companies, or non-governmental organizations.

Galicia & Zarco-Arista (2014) reviewed the literature identifying the range of ecosystem services provided by Mexican temperate forests, and interactions (trade-offs or synergies) between them. They concluded, first, that the knowledge of ecosystem services provided by temperate forests is still limited and more robust scientific information is necessary to better assist decision-making. Timber extraction is the main ecosystem service they provide, but this entails major trade-offs with other provisioning (water supply, bioenergy and non-timber forest resources) and supporting, regulating and cultural services. By contrast, the provision of cultural services, such as scenic beauty, has synergistic effects on support services such as nutrient and water cycling. Clearly identifying, quantifying and valuing the range of ecosystem services supplied by Mexican temperate forests can therefore help to move away from the prevailing forest management schemes narrowly based on logging and timber production, disregarding the trade-offs between timber extraction and other services, towards ecosystem management schemes based on the production of multiple services, including carbon storage and capture, water infiltration and filtration; prevention of soil erosion, etc. This knowledge is also essential for better informing decision-making and the design of environmental policy instruments, such as payment for environmental services.

To examine the state of the art on ecosystem services and payment for ecosystem services research, both worldwide and in Mexico, (Perevochtchikova, 2014; Perevochtchikova & Oggioni, 2014) reviewed 1 781 scientific papers published in international peer-viewed journals between 1992 and 2012. They found a growing trend in the number of studies published both, worldwide and in Mexico. Most of the publications reported on case-studies allowing for a closer, more direct focus on the social entities involved and their issues. The studies usually combined literature review with field work. In Mexico, most of the publications dealt with the valuation of ecosystem services and only few dealt with payment for ecosystem services schemes. There was a clear prevalence of studies with a social or biophysical focus. Biodiversity and hydrological services were the services most often studied. The studies showed a highly uneven geographical distribution and there was an increasing trend towards the use of modelling tools particularly for the study of hydrologic services.

INECC (2015 a, b) reviewed 31 studies valuing environmental goods and services supplied by Mexican forests, in order to systematize the information available on these themes, identify high-priority environmental services, and thus construct a framework to evaluate the cost-benefit and impact in social, economic and environmental terms of Mexico's payment for environmental services programme. Over half of the studies had a country-wide focus, while the rest focused on a single State or locality. Regulation services, particularly the regulation and maintenance of physical, chemical and biological conditions, were the services most often studied in Mexican forests, followed by provisioning (timber and non-timber forest products) and, then, cultural services involving physical or intellectual interaction with forests. The high variability of the estimates obtained for the economic value of physical interaction with forests (e.g. through ecotourism) was noticeable, as well as the scarcity of such evaluations. Overall, provision services yield the highest economic value, followed by carbon capture and the bequest value of forests. Benefit transfer was the valuation method most commonly used in these studies, followed by contingent valuation and, then, methods based on direct market price. The economic value estimated for the hydrologic services supplied by Mexican forests was surprisingly low and might rather be an artifact of the valuation method (contingent valuation) commonly used for this purpose.

Pérez-Verdín et al. (2016) conducted an in-depth analysis of 43 studies dealing with indirect or passive use ecosystem services valued by means of non-market methods. They included only studies that explicitly recognized the public nature of nonmarketed ecosystem services. Such services are usually subject to direct, indirect or passive uses, the value of which is often estimated based on the users' stated or revealed preferences. The studies examined addressed all three major categories of ecosystem services (regulating, provisioning, and cultural); the majority (70%) referred to terrestrial ecosystems and the rest to marine ecosystems, particularly in central Mexico and Baja California Sur. Most of them (27) relied on contingent valuation methods. They advocated for the continuation of research to highlight the critical role of ecosystem services in society.

Romo-Lozano et al. (2017) reviewed studies focusing on the economic value of forest biodiversity in order to identify the methods most commonly used, and the biodiversity components addressed. They found only 11 studies of this kind conducted in Mexico: three examined recreational services, five addressed hydrologic services and three others valued a bundle of services. All the studies looked at biodiversity at the ecosystem level. No studies looking at genetic or species-level biodiversity could be found. All the studies relied on the contingent valuation method and only one of those also used the travel cost method. They concluded that economic valuation of forest biodiversity is still incipient in Mexico, judging from the very few studies that have been conducted to date and the range of valuation methods used in them.

As part of the Natural Capital Accounting and Valuation of Ecosystem Services Project, Mkwara (2017) searched through different databases to identify studies conducted in Mexico that could

potentially be used in the SEEA-EEA ecosystem accounting context. She identified 98 studies published during the period 1992- 2017; as several of them valued more than one service, a total of 248 services were valued and summarized in terms of their study area, ecosystem services valued, valuation methods used, monetary values and authors. She found that most of the studies were carried out by academic institutions. The studies addressed all three major classes of ecosystems services in similar proportions, but very few studies focused on habitat services. 43 studies valued provisioning services, particularly food production, water supply, raw materials, and genetic resources. No studies evaluating ornamental resources were reported. 57 studies evaluated regulating services, including water flow regulation, climate regulation, waste treatment; moderation of disturbance, erosion prevention, biological control, air quality regulation and bundles of various not-clearly specified regulating services. No studies evaluating pollination services were reported. Only 11 studies addressed habitat services, and these were evaluated in rather broad terms loosely related to nursery and genetic pool protection services. A total of 27 studies valued cultural ecosystems services, including recreation and cognitive development. No studies evaluating aesthetics information, inspiration for culture or art and spiritual experience services were reported. The contingent valuation method was the preferred valuation method, being used in 75 out of the 248 services valued, particularly for regulating (water flow regulation) and cultural (recreation) services. Market price-based methods were the second most commonly used method, mainly for provisioning services, particularly food. Other valuation methods used include travel cost, choice experiments and other market-based valuation methods; the hedonic pricing method was used in only one study.

Finally, Lara-Pulido et al. (2018) conducted a meta-analysis of 106 published studies (which estimated economic values for 352 environmental goods or services) in order to feed econometric models aimed at generating robust estimates for the economic value of the ecosystem services valued. Contingent valuation was the valuation method most often used. They found that regulation services are the most valuable services, while wetlands are the most valuable ecosystem. The economic value of regulation services supplied by wetlands is also the most highly valued of all ecosystem services examined. The value of regulation services supplied by forests is higher than that of provisioning services supplied by agro-ecosystems, thus implying that deforestation and conversion to croplands, if properly valued, is not cost-effective in the long run. The value of cultural services is lower than any other service. No inference could be made for coastal ecosystems due to the small number of cases available.

Relevance and influence

The large number of studies that have been conducted in the country, encompassing a wide range of ecosystems, services and geographic locations and using different valuation methods, clearly shows the significant experience and technical capacities existing in Mexico for natural capital accounting and valuation of ecosystem services (INECC, 2015 a, b). In fact, two Mexican researchers (P. Balvanera from UNAM and M.L. Martínez from INECOL) are included among the 172 world's key authors of ecosystem services studies (Costanza & Kubiszewski, 2012) and a Mexican research institution, the Instituto de Ecología, A.C. (The Institute of Ecology, INECOL), ranks third worldwide in terms of number of peer-reviewed publications on this subject (Lithgow et al., 2017). As Fig.3d shows, several Mexican academic institutions (UNAM, Colegio de Posgraduados, Universidad Autónoma de Chapingo, Universidad de Baja California Sur, CIBNOR etc.) and governmental (CONAFOR, SEMARNAT-INE, and CONANP) have been actively working in this field.

It is also important noticing the recent but increasing use of and work on geospatial data, GIS and biophysical models to produce detailed, spatially explicit valuations of ecosystem services in Mexico. Examining ecosystem services in a spatially explicit manner plays a key role in ecosystem accounting, not

only under the SEEA-EEA framework but, more generally, as a tool to, for example, identify and prioritize areas by virtue of their high/critical supply of ecosystem services, or scarcity thereof; identify spatial trade-offs or synergies among various ecosystem services; recognize zones where multiple conservation goals can be aligned, etc. (Martínez-Harms & Balvanera, 2012; Pérez Verdín et al., 2017; Mokondoko et al., 2018). Mapping ecosystem services is also a more effective means to communicate complex information and raise awareness about the areas that supply key ecosystem services and those where such services are most demanded; about human dependence on functioning ecosystems; the between-regions flow of ecosystem services, etc. Thus, mapping ecosystem services is essential to bring the ecosystem services framework to practical use by decision makers in land-use planning, resource management, nature conservation, payment for ecosystem services, etc. (Brauman et al., 2007; Burkhard et al., 2012; Burkhard & Maes, 2017).

Avila-Foucat (2006) built an ecological-economic model to link a food web model, ECOPATH, to production functions for agriculture, fisheries and ecotourism in order to identify optimal watershed management strategies in Tonameca, coast of Oaxaca. Blackman et al. (2012) used a suite of air dispersion, health impacts, and valuation models to value air quality regulation services —in terms of human health damages caused by air emissions from two power-exporting plants in the U.S-Mexico border region. Ayuntamiento de Guadalajara & Espacios Naturales y Desarrollo Sustentable (2014) used multi-date vegetation/land-use maps derived from satellite imagery to assess changes in vegetation and land-use over time in ravines surrounding Guadalajara City and modelled the ravines' hydrologic balance in order to quantify carbon capture and storage and water supply services provided by the ravines' ecosystems. Borrego-Hernández et al. (2014) used an advanced spatial interpolation technique and population mobility data to value air quality regulation services —in terms of the health impacts of ozone pollution— in Mexico City. In a very comprehensive study of ecosystem services provided by coastal wetlands in northwest Mexico, Camacho-Valdez et al. (2013, 2014, 2016) used remote sensing, GIS tools, meta-regression analysis and Markov chain models to obtain more robust estimates of their monetary value and to examine how recent and projected future changes in land-use/land-cover affect ecosystem extent and the provision and economic value of such services. Mokondoko et al. (2016) used hydrological modelling GIS-based tools (Arc-Hydro) and land-use/land-cover maps derived from satellite imagery to assess water quality regulation services in central Veracruz by evaluating the capacity of forest cover, particularly that adjacent to rivers and streams, to regulate water quality and thus mitigate the effects of water-related diseases in neighbouring communities. The economic value of such services was estimated based on the public health costs associated with surface water contamination. CONANP-GIZ (2017a) used the InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) tool to quantify and value carbon storage and erosion control services provided by the Iztaccíhuatl-Popocatépetl National Park ecosystems. The SWAT (Soil and Water Assessment Tool) modelling tool was used to quantify water supply services. Regarding coastal and marine protected areas, CONANP-GIZ (2017b) used the InVEST tool to model and value the coastal protection services provided by coral reefs and mangrove forests of Cozumel Island. CONANP-GIZ (2017d) also used InVEST to model and value pollination, erosion control and water provision services provided by ecosystems in Mexico's federal protected areas, to highlight the contribution that protected areas make to the agriculture sector. Mokondoko et al. (2018) used land-use/land-cover maps derived from satellite imagery and the InVEST tool to quantify the provisioning and spatial distribution of water supply, soil retention and carbon storage services provided by ecosystems in central Veracruz and to examine the spatial congruence between priority (high-provision) areas and those targeted by the Mexican payment for environmental services programme. Schnitker & Burnett (2018) used digital land cover maps and the InVEST tool to estimate the volume and economic value of carbon sequestration in a community-owned, managed forest of northern Tlaxcala. Various harvest and end-product scenarios were examined to estimate their effect on carbon sequestration over a thirty-year horizon.

According to the reviewers (Pérez-Verdín, 2012; INECC, 2015 a,b; Pérez-Verdín et al., 2016; Mkwara, 2017; Lara-Pulido et al., 2018), the minimum elements that valuation studies should contain in order to ensure the usefulness of their results are, inter alia:

- A clear-cut, unequivocal identification of the environmental service(s) being evaluated; bundles of services should be avoided; for this, it would be important to adopt a common classification system of ecosystem services.
- The geographic location of both, the ecosystem(s) supplying the service(s) and its users.
- A characterization and quantification of the supplying ecosystem and the beneficiaries of the service. Studies should be designed to evaluate ecosystem services in both, physical and monetary terms, and also evaluate the service's demand and how these variables change over time
- Careful choice, unambiguous identification and detailed description of the valuation method used (including the discount rate applied, measurement units, etc.).
- Future studies when using contingent valuation should properly address the technical issues (such as survey design, definition of contingent valuation scenarios, and testing for the effect of survey variations).

It seems important to transition from the currently prevailing isolated case-study approach, towards longer-term, interdisciplinary studies, particularly involving decision-making actors, using a variety of carefully chosen methods and examining environmental as well as socio-economic effects (Perevochtchikova, 2014; Perevochtchikova & Oggioni, 2014; Lithgow et al., 2017; Lara-Pulido et al., 2018).

Annex D: Data sources

Table 7.- Major data sets collected and maintained by government agencies that are: a) directly useable, or b) that can be used as inputs for further analyses or models as the basis for examining the extent and condition of, or the services supplied by, Mexican ecosystems as per the SEEA-EEA methodological framework.

SEEA-EEA account	a) Directly useful/useable data sets	Dates/periods for which information is available	Spatially explicit? Scale? Scope?
Extent	Terrestrial ecosystems • Vegetation and land-use charts (INEGI) • Land cover reference map-MadMex (CONABIO-CONAFOR-INEGI-SEMARNAT)	1976, 1993, 2002, 2007, 2011 and 2014 2015 2017 (provisional) 2018 (provisional)	Fully spatial scale 1:250,000 Country-wide Fully spatial scale 1:20,000 Country-wide
	Freshwater ecosystems • Chart of hydrological basins (INEGI-INE-CONAGUA) • Hydrographic network (INEGI) • Chart of aquifers (CONAGUA)	2007 2010 2018	Fully spatial Scale: 1:250,000 Country-wide Fully spatial Scale: 1:50,000 Country-wide Fully spatial Scale: 1:250,000 Country-wide
	Coastal and marine ecosystems • Distribution of mangrove ecosystems in Mexico (CONABIO)	1970-1981, 2005, 2010, 2015	Fully spatial Scale 1:50,000 Country-wide
	Urban ecosystems • Urban and rural geostatistical chart (INEGI)	2016	Fully spatial Scale : ? Country-wide

Condition	Terrestrial ecosystems • Information on the conservation status of vegetation, as described in vegetation and land-use charts (INEGI)	1976, 1993, 2002, 2007, 2011 and 2014	Fully spatial scale 1:250,000 Country-wide
	• Water-caused soil erosion (INEGI)	2014	Fully spatial scale 1:250,000 Country-wide
	• Human footprint index (DGEIA-SEMARNAT)	2011, 2014 to be completed by late Jan 2019	Fully spatial 500m resolution Country-wide
	• Ecological Integrity Index (INECOL-CONABIO)	2014, update to be determined	Fully spatial 250m resolution Country-wide
	• Organic Carbon content in soil's top horizon (INEGI and CONAFOR)	Legacy data, 1960's to date	Partially spatial, georeferenced point data per sampling site Country-wide
	• Biodiversity: Collection records data for all major taxonomic groups, including distinction of endemic and threatened species (Sistema Nacional de Información sobre Biodiversidad-CONABIO	Legacy data, late XVIII century to date	Partially spatial, georeferenced point data per sampling site Country-wide
	• Federal Protected Areas (CONANP)	Cotinuously updated; latest version as of 2017	Fully spatial scale 1:250,000 Country-wide
	• Perimeters of certified agrarian nuclei (Registro Agrario Naciona)	2018	Fully spatial scale ? Country-wide
	Freshwater ecosystems • Surface water quality: Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Faecal coliforms (CONAGUA)	2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017	Partially spatial, georeferenced point data per monitoring station Country-wide
	• Federal Protected Areas (CONANP)	Cotinuously updated; latest version as of 2017	Fully spatial scale 1:250,000 Country-wide
	• Mexico's RAMSAR sites (CONANP)	2014, 2015, 2016	Fully spatial Scale: ? Country-wide
	<u>Coastal and marine ecosystems</u> • Index of Anthropic Influence in coastal zones associated to mangrove forests (CONABIO)	2005, 2010, 2015	Fully spatial 500m resolution Country-wide
	• Federal Protected Areas (CONANP)	Continuously updated; latest version as of 2017	Fully spatial scale 1:250,000 Country-wide
	• Mexico's RAMSAR sites (CONANP)	2014, 2015, 2016	Fully spatial Scale: ? Country-wide
	<u>Urban ecosystems</u> • Air quality data, National System of Air Quality Information (SINAICA-INECC)	Continuously updated	Partially spatial, georeferenced point data per monitoring station 32 major cities
Ecosystem services supply and demand	<u>Terrestrial ecosystems</u> • Forest exploitation permits (SEMARNAT)	Continuously updated; latest data as of 2018	Partially spatial, non-georeferenced data per municipality Country-wide
	• <u>Yearbook of forest production (SEMARNAT)</u>	1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004,	Partially spatial, data per State Country-wide

	• Statistical yearbok of agricultural production (SIAP-SAGARPA)	2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016 1980 – 2017 (not all the data series are complete)	Partially spatial, data per municipality Country-wide
	Freshwater ecosystems • Surface water availability (CONAGUA)	2014, 2015, 2016, 2017	Partially spatial, data per hydrological basin Scale: 1:250,000 Country-wide
	• Groundwater availability (CONAGUA)	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018	Partially spatial, data per aquifer Scale: 1:250,000 Country-wide
	• Public Registry of Water Users (REPDA-CONAGUA)	Continuously updated, latest data as of 2018	Fully spatial, georeferenced point data per concession Country-wide
b) Relevant, potentially useable data sets			
Description of data set		**Institution**	**Spatially explicit? Scale? Scope?**
• Primary statistical information on population, the economy and economic activities, education, public health, trade, jobs, households, transport, etc.		INEGI	Partially spatial, tabular data per State or municipality. Country-wide
• Geographical information on various themes encompassing natural (topography, physiography, etc.) and built features (urban and rural areas, infrastructure, etc.) of the territory, the environment and natural resources (soil, geology, climate, hydrology, etc.)		INEGI	Fully or partially spatial. Various scales, mainly 1:250,000 and 1:1'000,000 Country-wide
• National Forest and Soil Inventory; data for the two sampling cycles completed to date: 2004-2009 and 2009-2014		CONAFOR	Partially spatial, georeferenced data per sampling point Country-wide
• Geoinformation portal: Including over 8,000 maps either from other sources or directly produced by CONABIO-funded academic studies; maps encompass all the biodiversity-relevant themes.		CONABIO	Fully or partially spatial Various scales Local, regional and country-wide data sets.
• National System of Water Information: Geographical and statistical information on aquifers, watersheds, waterbodies, water availability, distribution and supply, water quantity and quality, irrigation for agricultural purposes, water concessions, wastewater generation and treatment, hydropower, weather, etc.		SINA-CONAGUA	Tabular, fully or partially spatial Various scales Country-wide
• Digital National Climate Atlas: Geographical data on weather, climate, extreme climate events, and climate change scenarios		UNIATMOS-INECC	Fully spatial Various scales Country-wide
• System of Agricultural Information: Statistical data on agricultural, livestock raising/ranching, fisheries and aquaculture activities and production		SIAP-SAGARPA	Tabular and partially spatial data (aggregated by Municipality) Country-wide
• National System on Tourism Information: Statistical data on tourism activities in Mexico		SNIEGT-SECTUR	Tabular and partially spatial data (aggregated by State) Country-wide
• National Inventory of Greenhouse Gases and Compounds Emissions		INECC	Tabular data Country-wide
• National Atlas on Climate Change Vulnerability and Results from commissioned studies		INECC	Analyses and fully-spatial information Various scales

		Country-wide and regional studies