Chapter 13
Blue Carbon in Emissions Markets: Challenges and Opportunities for Mexico

Antonina Ivanova Boncheva and Alfredo Bermudez-Contreras

Abstract Mangroves are ecosystems made up of trees or shrubs that develop in the intertidal zone and provide many vital environmental services for livelihoods in coastal areas. They are a habitat for the reproduction of several marine species. They afford protection from hurricanes, tides, sea-level rise and prevent the erosion of the coasts. Just one hectare of mangrove forest can hold up to 1,000 tons of carbon dioxide, more than tropical forests and jungles. Mexico is one of the countries with the greatest abundance of mangroves in the world, with more than 700,000 ha. Blue carbon can be a novel mechanism for promoting communication and cooperation between the investor, the government, the users, and beneficiaries of the environmental services of these ecosystems, creating public–private-social partnerships through mechanisms such as payment for environmental services, credits, or the voluntary carbon market. This chapter explores the possibilities of incorporating blue carbon in emissions markets. We explore the huge potential of Mexico's blue carbon to sequester CO_2. Then we analyse the new market instrument that allows countries to sell or transfer mitigation results internationally: The Sustainable Development Mechanism (SDM), established in the Paris Agreement. Secondly, we present the progress of the Commission for Environmental Cooperation (CEC) to standardize the methodologies to assess their stock and determine the magnitude of the blue carbon sinks. Thirdly, as an opportunity for Mexico, the collaboration with the California cap-and-trade program is analysed. We conclude that blue carbon is a very important mitigation tool to be included in the compensation schemes on regional and global levels. Additionally, mangrove protection is an excellent example of the mitigation-adaptation-sustainable development relationship, as well as fostering of governance by the inclusion of the coastal communities in decision-making and incomes.

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Introduction

Blue carbon ecosystems are "the coastal ecosystems of mangroves, tidal marshes, and seagrass meadows" (CI, IUCN and IOC-UNESCO 2019:2). Mangroves have an enormous capacity for sucking up carbon dioxide and other greenhouse gases and trapping them in flooded soils for millennia. In addition to their mitigation potential, they contribute to climate change adaptation stabilizing the coastal areas and protecting them from sea-level rise, storms, and soil erosion (Ibid). Mangroves also provide important ecosystem services as a habitat for the reproduction of different marine organisms. Their social contribution is also very significant in providing food and employment opportunities to coastal communities.

Governments, international actors (NGOs and academia), and local communities around the world are supporting coastal wetland conservation as a part of the mitigation strategy. The initiatives have varying levels of private sector involvement and different objectives, targets, and timelines. Some efforts focus on reducing emissions from deforestation and degradation, while others focus on negative emissions through the restoration of cleared or degraded landscapes. The United Nations Framework Convention on Climate Change (UNFCCC) is beginning to include blue carbon in the discussion of natural ecosystems. The existing REDD+ framework set-up under decisions of the UNFCCC COP specifies modalities for Measuring, Reporting, and Verifying (MRV) greenhouse gas emissions and removals (Park et al. 2013). Article 5 of the Paris Agreement explicitly calls for parties to take action to conserve and enhance sinks and reservoirs of greenhouse gases, including forests, and encourages countries to engage in cooperative approaches to this end. The explicit inclusion of forest and mangrove conservation is potentially a "game changer" as it encourages countries to safeguard ecosystems for climate mitigation purposes (Grassi et al. 2017) and facilitates the access of developing countries with abundant forests and mangroves to international carbon mitigation financing.

The objective of this chapter is to present Mexico's potential to involve blue carbon in the emissions trading system. First, we present the stocks of blue carbon in Mexico, the country with the greatest abundance of mangroves in the world, with more than 700 thousand hectares. Second, the potential of blue carbon as carbon storage is explored. Third, we analyse the opportunities that the new Sustainable Development Mechanism (SDM) introduced by the Paris Agreement is presenting for cap-and-trade and REDD+ mitigation options, especially for developing countries like Mexico. Further, we explore Mexico's collaboration with the California cap-and trade program, as a possibility to introduce blue carbon in the emissions trade. A case study of the Vizcaino Biosphere Reserve illustrates the country's likelihood of entering the blue carbon emissions markets. We conclude that blue carbon is a great area of opportunity for Mexico to perform mitigation strategies and participate in the regional and world cap-and-trade systems.

Blue Carbon in the World and Mexico

Climate Change and the Ocean

Total anthropogenic CO_2 emissions have been steadily and undoubtedly rising over the past decades and with them, the energy we trap on the planet. How emissions will behave in years to come depends on the decisions we make and the pathways we follow, as depicted in Fig. 13.1. According to the IPCC (2014), in excess of 90% of the energy accumulated in the climate system on Earth is in the ocean.

To make matters worse, alongside emissions growth and increased energy entrapment in the climate system, degradation of natural ecosystems that could serve as carbon sinks is also progressing, thus reducing their capacity to absorb CO_2 from the atmosphere. Fortunately, the mechanisms provided by forests to store carbon are well understood leading to the formulation of financial support schemes to promote their conservation in an effort to reverse the aforementioned trend. However, the carbon storage potential of ocean ecosystems, where 55% of biological carbon is captured (Nellemann et al. 2009), has not received enough attention in the fight against climate change.

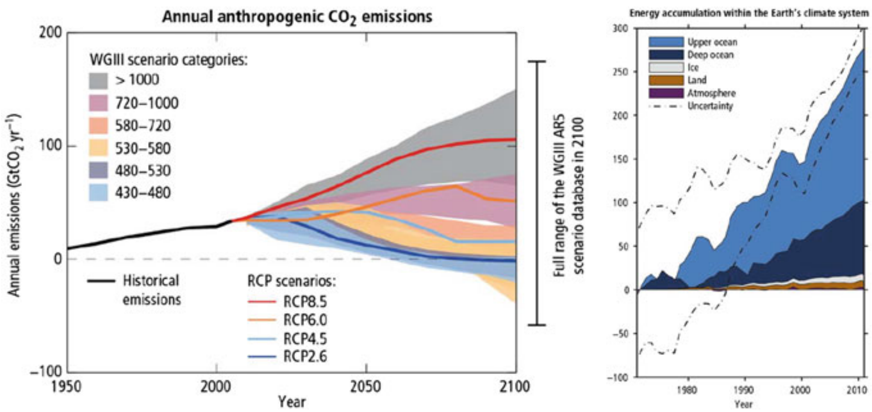


Fig. 13.1 Left: Annual anthropogenic CO_2 emissions history and IPCC scenarios. Right: Energy accumulation in the climate system. *Source* (IPCC 2014)

Blue Carbon

Coastal ecosystems can provide a wide range of services such as supporting fisheries, coastline protection from storms and sea-level rise, shoreline erosion prevention, water purification, biodiversity conservation, or providing food security for coastal communities, all of which are essential for climate change adaptation. Additionally, some of them can also work effectively to capture and store organic carbon acting as a carbon sink in the plants themselves and the sediments below. These include mangroves, salt marshes, and seagrass meadows. These ecosystems stretch through the land-sea interface covering supratidal (salt marshes), intertidal (mangroves), and shallow subtidal regions (seagrasses). In 2012, Pendleton et al. estimated the global extent of blue carbon ecosystems in the world to be 48.9 million hectares. The carbon stored in such ecosystems is referred to as blue carbon and accounts for perhaps as much as 71% of all carbon stored in ocean sediments (Ashok et al. 2019; CI et al. 2019; Nellemann et al. 2009; SEMARNAT 2017).

Blue carbon ecosystems are very fragile. Despite the enormous value found in the services they provide, economic development and human activities put them under sustained pressure. In fact, marine ecosystems are being lost at a faster rate than those based on land. The loss of these ecosystems due to unsustainable natural resource exploitation practices, poor watershed management, poor coastal development practices, and poor waste management is a serious threat for them and for the long list of services they provide in coastal regions, including carbon capture (uptake) and long-term carbon storage. Using a social cost of carbon of $41 per ton of CO_2 (2007 USD), Pendleton et al. (2012) estimated an annual global cost of blue carbon ecosystems conversion and degradation between $6.1 and $42 billion and noted that while damages to these ecosystems are located in a narrow strip along the coasts, the consequences are endured globally. Therefore, the management of marine ecosystems must be regarded as a desirable investment rather than an unnecessary cost. One method to promote their conservation and restoration would be their successful incorporation in carbon markets (Nellemann et al. 2009; OCM-NOAA 2018).

According to the Blue Carbon Initiative (www.thebluecarboninitiative.org), blue carbon ecosystems are found in all continents around the globe except Antarctica with the distribution presented in Fig. 13.2. The Blue Carbon Initiative reports loss rates of 1.5% per year for seagrasses and 1–2% per year for tidal marshes. They also report a loss of 30% of historical global coverage for seagrasses and 50% for tidal marshes (CI et al. 2019). Feller et al. (2017) report mangrove losses of 35% of their original area by the end of the twentieth century at global loss rates between 1–3% per year. Fortunately, this shows signs of improvement in the twenty-first century with loss rates of less than 1% per year and even as low as 0.16% per year between 2000 and 2012 (Feller et al. 2017; Hamilton and Casey 2016).

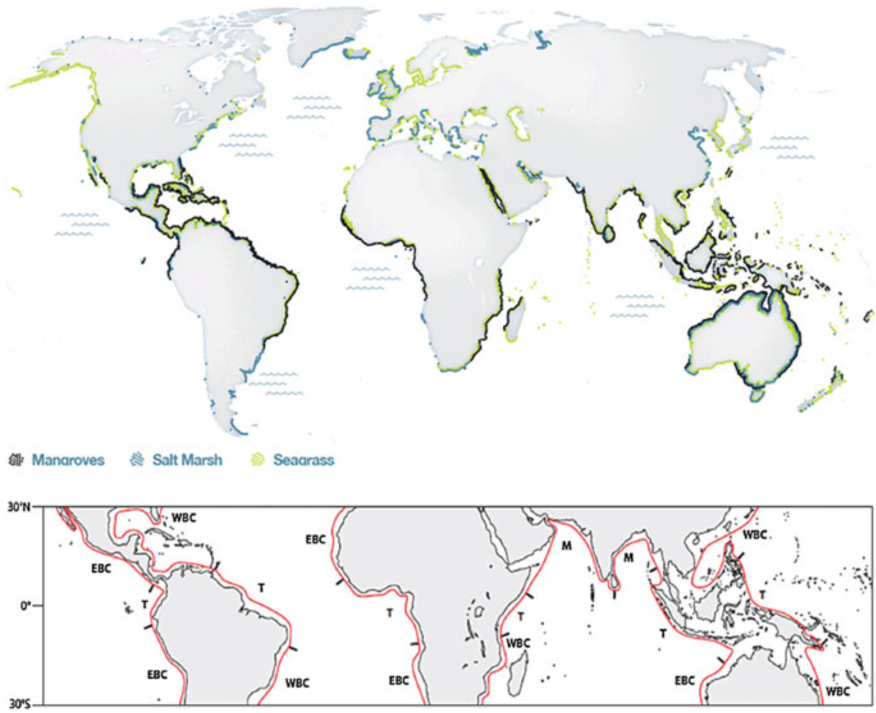


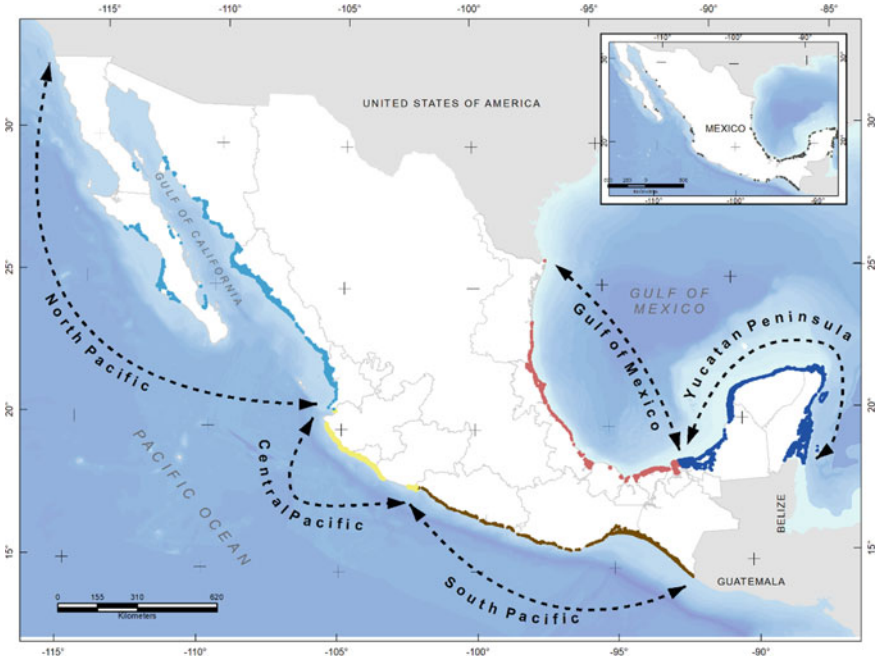
Fig. 13.2 Global distribution of blue carbon ecosystems (top) and mangroves alone (bottom). *Source* Top: Reproduced from CI et al. (2019). Bottom: Reproduced from Alongi et al. (2015)

Blue Carbon in Mexico

Mexico has considerable extensions of mangroves and seagrasses covering an estimated surface of 1.1 million hectares (Herrera-Silveira et al. 2020). Because of these ecosystems, Mexico has significant potential to capture and store blue carbon. Despite some protection provided by Mexican regulations, these ecosystems are under constant pressure from land-use changes for various purposes. Over the past 20 years, 24 Mt[1] CO_2 has been emitted in Mexico due to mangrove coverage loss (Herrera-Silveira et al. 2020). That's equivalent to 3% of the total emissions of Mexico in 2017 (INECC 2018). Financial schemes to support the conservation of blue carbon ecosystems in Mexico could help in maintaining a healthy stock of mangroves and seagrasses.

According to the most recent evaluation by Mexico's Biodiversity Commission (CONABIO), the country has a total mangrove surface of 775,555 ha (Valderrama-Landeros et al. 2017) distributed in five regions as shown in Fig. 13.3. The Yucatan Peninsula alone accounts for more than half of the total. Overall, this mangrove area

[1] 1 Mt equals 1 million metric tons.



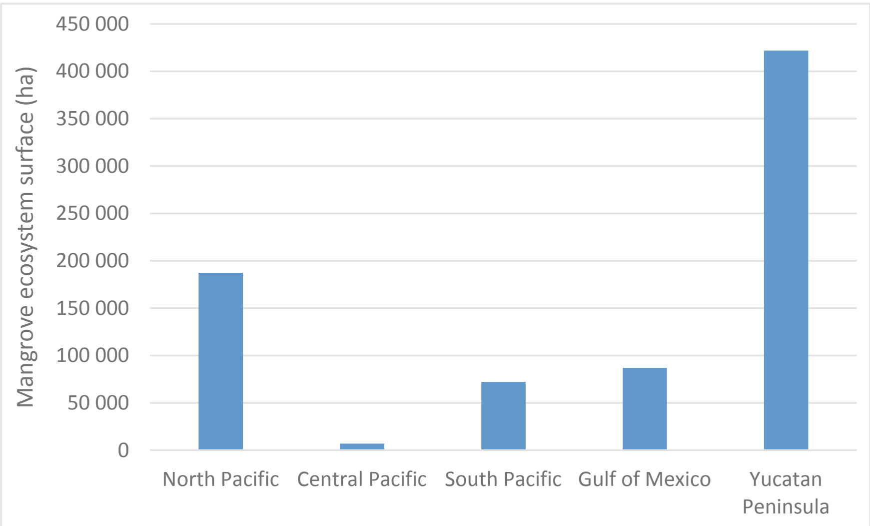


Fig. 13.3 Mangrove ecosystem surface by region in Mexico. *Source* Top: Reproduced from Herrera-Silveira et al. (2020). Bottom: Authors' elaboration with data from Valderrama-Landeros et al. (2017)

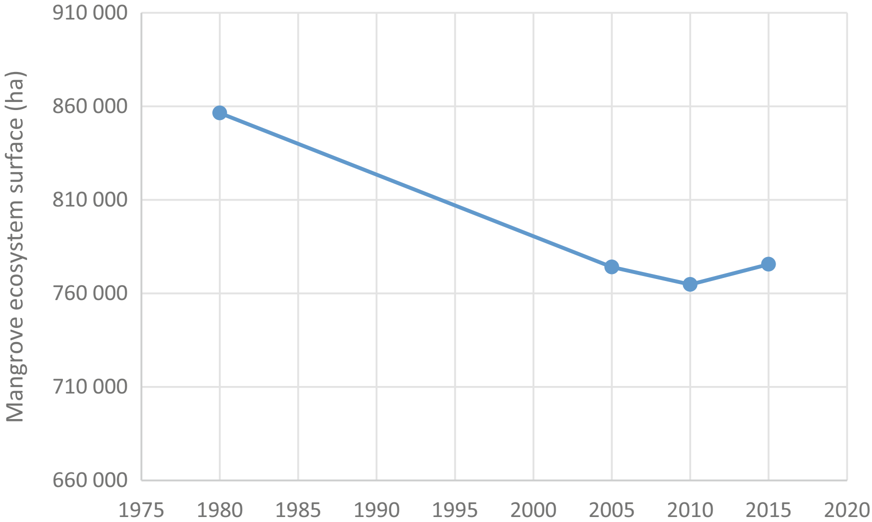


Fig. 13.4 Evolution of mangroves in Mexico. *Source* Authors' elaboration with data from Valderrama-Landeros et al. (2017). The value presented for 1980 corresponds to the aggregation of data for individual states during the 1970s and 1980s as presented by Valderrama-Landeros et al. (2017)

had a net loss of 9.4% between the 1970/1980 records and 2015, with a small recovery between 2010 and 2015 (Fig. 13.4). Hamilton et al. (2016) ranked Mexico in the top 10 countries with the most mangrove forest area but Mexico was also ranked in the top 10 countries with the highest annual total area of mangrove deforestation between 2000–2012 (Feller et al. 2017). Nevertheless, some steps are already being taken in the right direction. The "Adaptation and Blue Carbon" project is the first adaptation project in Mexico funded with national resources through the Climate Change Fund created by the General Law of Climate Change.[2]

Carbon Storage

Annually, between 235–450 Mt of carbon are captured and stored by blue carbon ecosystems around the world (Alongi 2014). The attention that these ecosystems and mangroves, in particular, have received as carbon sinks is due to their disproportionately high capacity to trap carbon in the long term in relation to the area they cover (see Fig. 13.5). However, as could be reasonably expected, not all mangrove plants around the world are the same nor are the conditions they grow in. Plant species, local climate, coastal geomorphology, fertility gradients, hydrodynamic types, and

[2] A video summarizing the experience in this project can be found in www.youtube.com/watch?v=zvDtxrizRws (04 May of 2020).

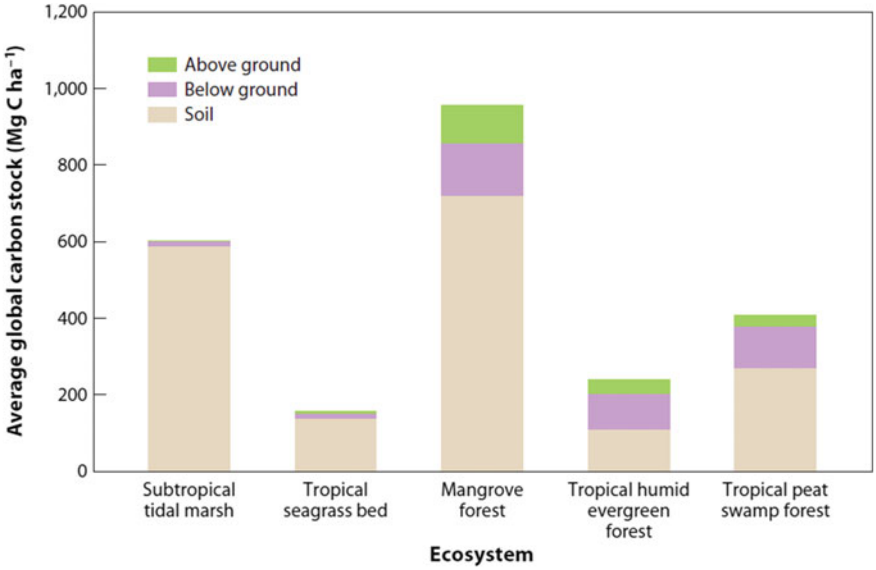


Fig. 13.5 Average global carbon stocks of various ecosystems. *Source* Reproduced from Alongi (2014)

even surface salinity are all factors that affect carbon storage capabilities per unit area (Herrera-Silveira et al. 2020; Ochoa-Gómez et al. 2019). Figure 13.6 presents

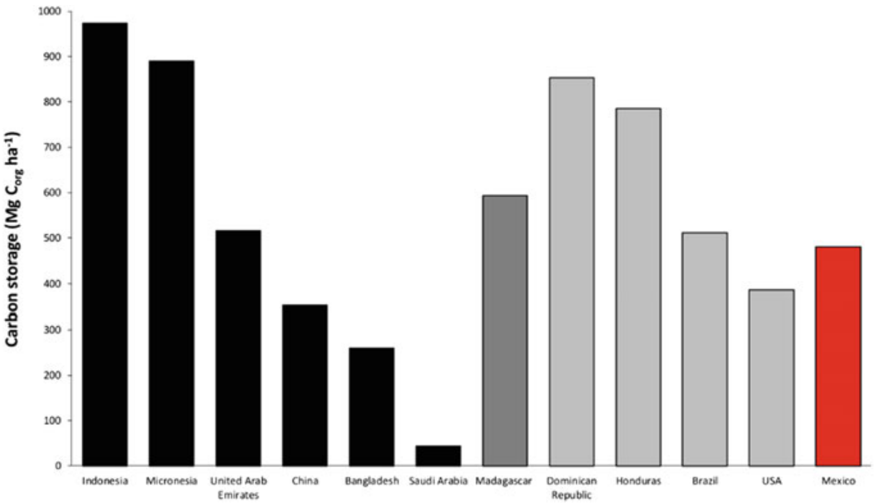


Fig. 13.6 Organic carbon stores per unit area in mangroves around the world. *Source* Reproduced from Herrera-Silveira et al. (2020)

Fig. 13.7 Mangrove distribution in VIBIRE. The Reserve is in a darker shade; mangrove ecosystems are in red. *Source* Authors' elaboration with data from Google Earth, CONANP (2000), and CONABIO (2015)

a comparison of unit carbon storage for mangroves worldwide. It is then clear that there is a wide range of carbon capture capacities for these ecosystems (Fig. 13.7).

Despite the different carbon storage capacity of mangroves in various places, in general, they maintain similar amounts of carbon in their living biomass as other vegetated ecosystems. However, a larger benefit lies in the carbon stored in the soil over which they are located and that they successfully create through various mechanisms. These soils are carbon-rich environments that can extend several metres deep where lack of oxygen and other factors constrain decomposition (Pendleton et al. 2012). This is at the same time why the conversion of mangroves to other land uses also poses an enormous risk as a climate change contributor. In converted or degraded mangrove regions, surface vegetation harm will not only result in a loss of atmospheric carbon uptake capacity but, more importantly, lead to the unlocking and decomposition of the organic carbon contained in these soils, ultimately resulting in pulses or spikes of greenhouse gases released back into the atmosphere. Estimates of emissions released to the atmosphere in the range of 150–1020 Mt CO_2 each year (central value: 450 Mt) have been reported due to the degradation and conversion of coastal ecosystems (Pendleton et al. 2012). To put this into perspective, Mexico's total greenhouse gas emissions in 2017 (734 Mt CO_2e, INECC 2018) are within that same range. Therefore, conserving and adequately managing mangroves to ensure the long-term permanence of those carbon stores is of paramount importance, firstly for their climatic benefits but also for the long list of valuable other services they provide.

Sustainable Development Mechanism (SDM) of the Paris Agreement

The 2015 Paris Agreement to the UNFCCC is at the centre of international cooperative efforts for climate change mitigation and adaptation in the post-2020 period. Although its legal form was heavily disputed in its four-year negotiating process (Dagnet et al. 2016). The overall purpose of international cooperation through the Paris Agreement is to enhance the implementation of the UNFCCC, including its objective of stabilizing atmospheric GHG concentrations "at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC 1992 Art. 2).

Article 6.1 of the Paris Agreement recognizes the role that cooperative approaches can play, on a voluntary basis, in implementing parties' Nationally Determined Contributions (NDCs) "in order to allow for higher ambition" in their mitigation actions and to promote sustainable development and environmental integrity. It lists a number of specific types of cooperative approaches that come within its ambit, including Internationally Transferred Mitigation Outcomes (ITMOs), a "mechanism to contribute to mitigation and support sustainable development", and a framework for non-market mechanisms (UNFCCC 2015; Morgan and Northrop 2017).

Article 6.2 suggests ITMOs can originate from a variety of sources including regional carbon markets or REDD+. While this provision, unlike similar provisions in the Kyoto Protocol, does not create an international carbon market, it enables parties to pursue this option should they choose to do so, for example, through the linking of domestic or regional carbon markets (Ivanova et al. 2020). Article 6.2 could also be implemented in other ways, including direct transfers between governments, linkage of mitigation policies across two or more parties, sectoral or activity crediting mechanisms, and other forms of cooperation involving public or private entities or both (Linn 2016). Wetlands International, together with the Australian Government, organized the event "Incorporating Blue Carbon into Nationally Determined Contributions under the Paris Agreement" at the UN Climate Change Conference, COP22, in Marrakesh (Ullman et al. 2013; Herr et al. 2015). In 2013, Mexico began to explore the options to include blue carbon in countries' NDCs (Pronatura Sur A.C. 2016).

Article 6.4 concerns the mitigation mechanism, referred to by some parties as the "sustainable development mechanism" or SDM. It is a mechanism that has as output GHG emissions reductions, which can be used by any party towards its NDC. However, the limit exists that emission reductions cannot be used by the host party if another party applies them to demonstrate the achievement of its NDC. Unlike the Clean Development Mechanism (CDM), there is no restriction specified regarding which parties can host mitigation projects and which parties can use the resulting emissions reductions towards their NDCs (Streck et al. 2016). The SDM will operate under the authority and guidance of the CMA[3] and is to be supervised by a body designated by the CMA in a similar fashion to the CDM.

The SDM also has a mission to foster sustainable development. The decision adopting the Paris Agreement specifies experience with Kyoto mechanisms like the CDM as a basis for the new mitigation mechanism (UNFCCC 2016). Compared to the CDM under the Kyoto Protocol, which had a climate-centric focus on measuring emissions reductions, the SDM has a more balanced focus on both climate and development objectives and a stronger political mandate to measure sustainable development impact and to verify that the impacts are "real, measurable, and long-term" (Olsen et al. 2018).

Blue Carbon in North America: Assessing the Role of Coastal Habitats in the Carbon Balance of the Subcontinent

As a member of the Commission for Environmental Cooperation (CEC),[4] Mexico is involved in various trilateral projects. The CEC's first blue carbon project is a tool that facilitates the inclusion of Mexican blue carbon in the emission markets. It contributes to the conservation and restoration of coastal habitats that capture and store CO_2. The project systematizes the information, mapping, and approaches necessary to fill gaps in our knowledge of carbon dynamics in carbon ecosystems as marshes, mangroves, and beds (CEC 2014, CCEA 2015).

The progress of the project is presented as follows:

- Establishment of a community of scientific practice around blue carbon in North America to promote cooperation and the exchange of knowledge among experts on the subject in the three countries.
- Integration of a common set of data on habitats that capture and store blue carbon. This dataset includes maps, carbon emission counts, and data on emission potential, uptake, and storage, as well as documented methods, information, and results. The information will be available in the Environmental Atlas of North America (King 2012).

[3] CMA is the short form for the group of the countries who have signed and ratified the Paris Agreement. The full name of this governing body is "Conference of the Parties serving as the meeting of the Parties to the Paris Agreement".

[4] Since 1994, Canada, Mexico, and the United States have collaborated in protecting North America's environment through the North American Agreement on Environmental Cooperation (NAAEC). Accordingly, the NAAEC established an intergovernmental organization—the Commission for Environmental Cooperation (CEC)—to support cooperation among the NAFTA partners to address environmental issues of continental concern, including the environmental challenges and opportunities presented by continent-wide free trade (CEC n.d.).

- Completion of the first step in formulating an internationally recognized methodology to include ecosystem conservation projects that capture and store blue carbon in voluntary carbon markets.
- New information and methods from different scientific studies that help fill gaps in our knowledge of carbon dynamics in habitats that capture and store blue carbon, including both healthy and disturbed sites (CEC 2016).

  The following products have been generated based on the results of the joint work:
- The first set of blue carbon storage habitat maps for North America showing the mapping of 47 776 km^2 of this habitat type conducted to date.
- A tri-national workshop with the blue carbon community of practice and one with experts in blue carbon, forest carbon, and land cover (WCMC 2016).
- Publication of the report on methodological criteria for offsetting greenhouse gas emissions in favour of intertidal wetland conservation and derived recommendations.
- Five research projects on coastal habitats that capture and store blue carbon are as follows:

  (1) Observation of carbon accumulation indexes in coastal marshes and their response to sea-level rise.
  (2) Levels of uptake and storage of blue carbon in northern marshes: evaluation of processes, reserves, and accumulation rates of the element in undisturbed, drained, and restored marshes.
  (3) Carbon reserves in mangroves and marshes in the most extensive wetlands in Mesoamerica: the Centla swamps, Mexico.
  (4) Carbon stocks in seagrass bed systems across a range of environmental conditions and seagrass types, with the aim of determining the amount of carbon deposited.
  (5) Spatial variability of carbon storage within the marshes belonging to the United States National Estuarine Research Reserve System for (NERRS): comparison of methodologies and coastal regions (Ivanova 2019).

This cooperation mechanism is an important tool for Mexico to evaluate blue carbon availability in the country and to develop the necessary methodologies for comparative studies.

California Cap-and-Trade Program

California decided that a cap with a broad scope would be the most effective way to ensure that the state could meet its mitigation targets. At its launch in 2013, California's program covered all six greenhouse gases (GHG emissions) within the industrial and electricity sectors (EDF 2014). In 2015, the cap coverage expanded to transportation fuels and natural gas, bringing about 85% of state emissions under the cap. Emissions from imported electricity and fuel are included in the cap, though the cap does not cover emissions from sectors that are currently challenging to measure or regulate on a large scale, such as agriculture and fugitive emissions (EDF 2018).

In 2010, California and representatives of Acre, Brazil, and Chiapas, Mexico, signed a Memorandum of Understanding (MoU) that led to the establishment of a working group to provide guidance to California on fighting tropical deforestation and carbon pollution around the world through innovative policies that reduce Emissions from Deforestation and Degradation (REDD). The working group examined design elements, including legal and institutional aspects and social and environmental safeguards, to develop a jurisdictional scale REDD credit-trading system that could be used for compliance within California's carbon market (ROW 2013).

Chiapas has been developing a state-wide approach to REDD+, but it is at an earlier stage than Acre, Brazil (EDF 2015). Chiapas is identifying and beginning to assimilate the substantive and procedural elements needed to build a successful jurisdictional REDD+ program that will work within the Mexican context (Herrera Silveira and Teutli Hernández 2017). It also brings an important set of experiences regarding land tenure, indigenous rights, and participation, highlighting the critical importance of establishing a process that incorporates all stakeholders from the beginning in designing and building jurisdictional programs for REDD+ and low emissions development.

A very small amount (about 5%) of emissions reductions from California Commerce-included industries can be purchased through uncapped sources, including forestry ("green carbon") here. California has begun to expand this trade to neighbouring states and even to the international arena with highly forested countries with which it can offset its emissions, such as Brazil, Indonesia, or Mexico, and has already begun to work with the scheme of the certifying organization VCS (Lopomo et al. 2011). Currently, the California scheme is focused on qualifying blue carbon as a compensation category. It is yet to be decided whether this category will be applicable exclusively to bonds within California, or also to compensation from other countries included in California Commerce, such as Mexico. This may be a good opportunity for Mexico, as it adjusts very well to the requirements of this ETS and the scheme of working between states. In this way, the compensation scheme would come to adhere to state climate change strategies.

The Mexican Emissions Trading System Pilot Program

On 1 January 2020, the Ministry of the Environment and Natural Resources (SEMARNAT) launched the Emissions Trading System Pilot Program, which aims to promote the reduction of emissions at the lowest possible cost, and which will last for three years, in compliance with the Reform of the Mexican General Law on Climate Change.

During the pilot program, only facilities whose annual emissions are equal to or greater than 100,000 tons of direct carbon dioxide emissions will participate.

According to the Regulations of the National Emissions Registry, the following activities are considered:

(1) In the energy sector: exploitation, production, transportation, and distribution of hydrocarbons and generation, transmission, and distribution of electricity.
(2) For the industrial sector: automotive industry, cement and lime industry, chemical industry, food and beverage industry, glass industry, steel industry, metallurgical industry, and mining industry.

Blue carbon and forestry are sectors not regulated by the pilot program. However, the ETS can incentivize CO_2 reductions in unregulated sectors. Mitigation projects in these sectors can be submitted to inspection under approved protocols to guarantee the quality of their reductions. Approved projects can access offset credits to achieve the mitigation goal. It is a good opportunity to promote blue carbon, but the priority of offset credits is still the regulated sector (SEMARNAT and GIZ 2020).

Case Study: El Vizcaino Biosphere Reserve[5]

Baja California Sur is an arid state in Northwest Mexico. With more than 2,100 km (SPYDE 2015), the state has the longest coastline in the country, where blue carbon ecosystems can be found. According to CONABIO's most recent report (Valderrama-Landeros et al. 2017), as of 2015, the state had 26,579 ha of mangroves. Unlike other places in Mexico and the world, mangrove coverage in Baja California Sur has been very stable over the past four decades (26,724 ha in 1978), losing only 0.5%. Nevertheless, mangrove ecosystems in Baja California Sur are not static but rather the result of a dynamic equilibrium of losses and gains balancing out (López-Medellín et al. 2011; Watson and Corona 2018).

Natural Protected Areas (NPA) in Baja California Sur cover more than 40% of the state total surface of 73,308 km^2. The El Vizcaino Biosphere Reserve (VIBIRE) located in the north of the state is the largest NPA in the country with an area of 2.5 million hectares. The San Ignacio Lagoon in the Reserve is an important location for biodiversity including considerable mangrove extensions. CONABIO reported that in 1978 the Lagoon and neighbouring estuaries La Bocana and El Datil had a combined 3,672 ha of mangroves. By 2005, this was reduced to 3,607 ha but recovered by 2010 for a total of 3,799 ha.

An estimate of the total carbon stock in the San Ignacio Lagoon and neighbouring estuaries can be worked out using the organic carbon stock value reported by Herrera-Silveira et al. (2020) for mangroves in the North Pacific region in Mexico of 204.9 Mg C_{org} ha^{-1}. This includes both above- and below-ground stocks and results

[5] We present this case study in the chapter to highlight the potential of the blue carbon in the emissions trade of Mexico. The results that presents the Vizcaino Biosphere Reserve are an example of the great possibilities that the inclusion of the blue carbon in the emission trade can represent for Mexico. The blue carbon could be included in the Californian cap-and trade system and as a non-regulated sector in the Mexican cap-and trade system.

in 0.778 Mt of organic carbon in the Lagoon region. If all this carbon were oxidized fully to form carbon dioxide, this would translate to 2.85 Mt CO_2 in total. To put this into perspective, this would be in the same order of magnitude as the reported greenhouse gas emissions for the whole state of Baja California Sur in all categories in 2010 of 4.16 Mt CO_2e (Ivanova and Gámez 2012). Finally, using the social cost of carbon[6] reported by Pendleton et al. (2012) of US 2007 $41 per ton of CO_2, the 0.778 Mt of organic carbon in the Lagoon would equate to 117 million dollars in global costs if these mangroves were converted, which as the data suggests is fortunately not happening. As compelling as these figures may be, without the adequate mechanisms in operation at the required scales, mangroves and their management around the world will not be valued for their superb carbon sequestration capacity in the long term and will continue to sustain pressure from economic development and human activities.

Conclusions

In the short and medium term, expansion of mangrove ecosystems provides many environmental services such as supporting fisheries, coastline protection from storms and sea-level rise, shoreline erosion prevention, water purification, biodiversity conservation, or providing food security for coastal communities, all of which are essential for climate change adaptation. However, in the long term, expansion and conservation of mangroves translate into enhanced carbon stores, which is of great value in the mitigation of climate change.

However, in its broadest understanding, mitigation activities—as well as climate change adaptation and conservation activities—can also include national capacity building or awareness-raising efforts (e.g. enabling stakeholders to use mangroves in a sustainable manner), support for institutional set-up, developing and implementing sectoral policies, enforcing changes in national legislation, and engaging stakeholders. The goals for mitigation are most prominently aligned with climate adaptation objectives, especially for nature-based solutions such as in agriculture, forestry, and the rural land-use sectors. Recognition of how climate change is likely to influence other development priorities, as access, justice, and allocation, may be a first step towards building cost-effective strategies and integrated, institutional capacity in Mexico to respond to climate change.

The present analysis found that the integration of the concept of blue carbon in Mexican public policy is an important area of opportunity. However, there are some challenges to be faced. In the first place, an official Mexican standard specifically regulating matters related to blue carbon must be drafted, proposed, and implemented. Others are property rights; the federation, state, and community areas of influence; and access to the international green funds. Currently, there are substantial shortcomings in the functioning of the institutional framework for sustainable

[6] Global economic cost of new atmospheric carbon (Pendleton et al. 2012).

development. Mitigating climate change, adapting to sea-level rise, and alleviating coastal communities' poverty can all be complementary.

The international commitments of Mexico involve both mitigation and adaptation actions, and in both cases, conservation and restoration of blue carbon ecosystems is the best solution in terms of cost-effectiveness (CEC 2017).

Mexico as part of the Paris Agreement can use ITMOs to achieve their NDCs but when engaging in this activity shall promote sustainable development, ensure environmental integrity, ensure transparency, including in governance, and apply "robust accounting" in accordance with CMA guidance to prevent double counting. Additionally, as a member of the CEC, Mexico participates in the regional assessment of blue carbon stocks and shares with methodologies for implementation and monitoring the U.S. and Canada. Under this scheme, the compensation scheme would come to adhere to state climate change strategies.

The best resource for this is the creation of a national regulated emissions trading system—similar to and supported by the California Emissions Trading System (ETS)—that includes blue carbon through the guidelines imposed by the specific Mexican official standard, and with a system of concessions to be able to assign carbon credits. Currently, the Mexican ETS is in the pilot phase and only considers the energy and industrial sectors as regulated. The creation of the ETS in Mexico is based, therefore, on the lessons learned and good practices carried out by international and national voluntary markets and implemented through a strategy at all levels of government, where financing and capacities flow from the international to the local and community level. Considering the great potential of Mexico to benefit from blue carbon in emissions trading, we strongly recommend including it among the regulated sectors during the next phase of ETS.

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