DEEP BLUE

Opportunities for **BLUE CARBON FINANCE** in coastal ecosystems

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Acknowledgments

This paper was developed by IFC Climate Business Department in collaboration with Silverstrum and Climate Focus to provide an overview of the emerging blue carbon market. The IFC team included Steven Baillie and Irina Likhachova, with additional input from Kiyoshi Okumura and support by Maxwell Klotz and Beatrice Phillips. The Climate Focus and Silverstrum team included Adriaan Korthuis, Moritz Von Unger, Gabriela Martinez se la Hoz, Igino Emmer, Felipe Bravo, Andrés Zabala, and Elisa Perpignan.

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Overview

Nature-based solutions focused on conservation and restoration of coastal ecosystems are a cost-effective way of reducing greenhouse gas (GHG) emissions. Carbon credits generated from blue carbon projects can be used by companies to neutralize their carbon footprint or by governments to support their Nationally Determined Contribution (NDC) commitments under the Paris Agreement.

Despite growing demand for blue carbon credits and increasing interest in these types of projects, blue carbon projects are still in need of funding. Capital to support climate mitigation activities is available but is slow in finding its way to appropriate projects. Carbon markets have an important role to play as they are able to quickly and efficiently mobilize funding to support mitigation activities.

Coastal blue carbon

The term "coastal blue carbon" is associated with tidal wetlands, particularly the management of mangroves, saltmarshes, and seagrass meadows. Although these ecosystems occupy only 0.2 percent of the globe, they are hotspots for carbon storage, as their soils sequester 10 times more carbon than terrestrial ecosystems.

When these ecosystems are degraded and converted, carbon in their biomass and soil, which has accumulated over an extended period, is oxidized and emitted back into the atmosphere in a matter of decades. Studies estimate that around 0.2 gigatons (Gt) to 0.24 Gt of CO_2 equivalent (CO_2e) are being released annually from conversion and degradation of these ecosystems. This represents between 3 percent and 19 percent of global deforestation, resulting in economic damages of $6 billion to $42 billion each year.

Blue carbon solutions focus on two main mitigation options: conservation and protection, and restoration. Conservation involves halting loss and degradation of the ecosystem, and directly changing land use. Protection on a per unit area basis offers high emissions reduction benefits because of the density of carbon stocks in their biomass and particularly in soils. The restoration of degraded blue carbon ecosystems is more complex and could require a suite of activities, but mainly involves rehabilitating the soil and associated organisms and restoring their ability to store carbon.

Beyond their climate mitigation potential, tidal wetlands provide essential ecosystem services such as fish, timber, coastal protection, and pollution control. They also offer recreational, tourism, and additional livelihood opportunities for local communities. Given these benefits, protecting and restoring them is a way for countries to increase their structural and economic resilience to the effects of climate change.

State of voluntary carbon markets

Net-zero commitments by companies, cities, and other organizations tripled between 2020 and 2021, with 2,253 companies aligning with the Science Based Targets initiative guidelines. Neutralizing residual carbon emissions and compensating ongoing emissions are often part of the ensuing net-zero pathways. As a result, the value of voluntary carbon markets' issuances exceeded $1 billion in 2021. Issuance of carbon credits nearly doubled in 2021 compared to 2020, amounting to 353 metric tons of CO_2e and representing 30 percent of the total credit issuance since the market's inception. Additionally, in 2021, retirements of carbon credits increased by 70 percent relative to 2020 values to cater to the surge of net-zero commitments. In 2021, nature-based solutions and renewable energy projects accounted for more than 80 percent of total credit issuances.

Carbon pricing

The recent surge of carbon prices is expected to continue, from a range of $15 to $24 in 2022 to $40 to $65 in 2040. Blue carbon projects could fetch prices at the higher end of these ranges. The prices that can be expected for credits from blue carbon projects are considerably higher than the prices paid for credits using a generic REDD+ results-based finance approach (where prices range between $8 and $10). Mangrove restoration and afforestation/reforestation can command prices of between $15 and $35 per credit plus potential premiums due to sustainable development benefits.

It is expected that the prices of blue carbon offsets will increase relatively steeply during the first half of this decade, then slow in the second half. Price is driven mainly by the overwhelming demand from corporates to fulfill their net-zero targets and support their carbon neutrality claims, and the lack of supply to fulfill the demand. After 2030, the price of blue carbon offsets is expected to plateau, as more supply enters the market, while the level of uncertainty rises over time.

Financing blue carbon projects

Mobilizing capital investments for conservation remains a primary obstacle to managing and restoring coastal blue carbon ecosystems. There is growing understanding of the variety of obstacles and barriers to financial scaling in general, and of the roadblocks for private sector financing of nature-based solutions in particular. Specific barriers linked to carbon project development include:

- **High risk profile of blue carbon projects**: Banks and investors lack the strategy and capabilities to commit to a relatively marginal asset class in which ticket sizes tend to be small compared with the effort required. Business models that rely on carbon credits must allocate funds for validation, monitoring, and verification processes before issuing carbon credits, contributing to the upfront costs and the time lag between initial investments and returns from selling carbon credits.
- **Small project scale and long time frames**: For blue carbon ecosystems, it is difficult to reach a cost-effective scale for conservation or restoration projects. An additional uncertainty related to risk-return profiles is the long-term propositions to scale.
- **Climate change impacts**: Studies suggest that tidal wetlands are particularly vulnerable to the effects of climate change, such as sea level rise and warming, with potentially higher degradation rates than terrestrial ecosystems.
- **Institutional complexities and lack of capacity**: Many countries and national agencies lack the experience, technical expertise, and financial literacy to develop carbon projects in tidal wetlands. Moreover, the slow translation of international policies to national and subnational levels might hinder domestic plans and applicable regulations, and tidal wetlands are usually not mainstreamed in the design of public infrastructure projects.
- **Land tenure and engaging with coastal communities**: Land tenure is a significant bottleneck for investment in sustainable land management forms. The conservation of tidal wetlands involves many stakeholders and requires multifaceted community-led development projects to address underlying drivers of destruction and unsustainable use.

In recent years, a range of new financing sources and structures has emerged that can help bridge the financing gap and tackle specific challenges around blue carbon project development, especially if combined with blended finance products. The transition to a sustainable blue economy creates opportunities for multiple investment and financing streams that can complement blue carbon finance in the mid to long term.

Structures and sources of finance

The various financing sources can be categorized as follows:

- **Stand-alone blue carbon finance:** Stand-alone blue carbon assets can be built using voluntary carbon markets. They may also come in the form of non-market, results-based finance approaches (as has been done for REDD+).
- **"Nested" blue carbon considerations in value chains:** Blue infrastructure aims to replace traditional "gray" infrastructure (such as dams, levees, and reservoirs) with "blue" elements (such as mangrove forests and floodplains), or combine both to enhance the overall effect of the infrastructure and the habitats concerned. The carbon footprint of sectors such as agriculture, aquaculture, and tourism can be substantially reduced through the use of nature-based solutions, which, in turn, can make the investment more resilient and augment the underlying asset.
- **Blue finance:** The EU sustainable finance taxonomy, the Green Bond Principles, the Green Loan Principles, and IFC's Guidelines for Blue Finance identify which types of investments can be deemed green or blue, and at what scale. This guidance is supported by transparency provisions on risks posed by environmental degradation, such as those identified by the Task Force on Climate-related Financial Disclosures.
- **Insurance and resilience:** Given that natural wetlands can limit storm damage in coastal areas, insurance markets will be interested in how investments in wetland restoration can help reduce property damage.
- **Debt instruments (including bonds):** Corporations and governments increasingly use green – and more recently blue – bonds focused on nature conservation, restoration, and sustainable use, especially in jurisdictions that are known for their natural capital and ecosystems.

Opportunities for financial institutions (FIs)

As blue carbon projects are in high demand, a number of large buyers are willing to commit to forward carbon credit agreements and offer amenities, including premium prices and upfront payments. FIs can play an instrumental role in this market by:

- Offering firm carbon purchase agreements to developers of blue carbon projects, particularly when the requested price for carbon credits is above the current appetite of major buyers or when the proposed intervention is still in the proof-of-concept phase. By acting as a primary buyer, offering premium prices, and providing partial upfront finance, FIs can enable the development of highly visible yet costly tidal ecosystem restoration initiatives.
- Promoting the implementation of nature-based solutions in coastal infrastructure projects in which it is participating as a financier. As the scale of the blue carbon parts of these investments would likely be limited, FIs can propose and coordinate bundling these interventions into carbon programs.

FIs could also support the development of the blue carbon market by:

- Providing financial assistance and advisory services to insurers in developing markets to tailor flood risk policies to wetland enhancement interventions.
- Designing "blue" bond products to focus on coastal wetland conservation and restoration activities and defining workable metrics and impact frameworks to evaluate the use of relevant proceeds.

1.

Background

1.1 Context

Ocean-based climate mitigation activities are an indispensable part of the solution to tackle climate change. Changing practices in ocean-based transport, ocean-based renewable energy projects, and fisheries as well as protecting coastal and marine ecosystems and carbon storage in seabeds can potentially close up to 21 percent of the emissions gap between the current policy baseline and the pathway to limit global heating to 1.5°C.[1] Despite oceans absorbing up to 30 percent of the manmade carbon dioxide (CO_2) emissions that contribute to global warming, the development and implementation of mitigation projects and programs for oceans have lagged those for land-based forestry projects.

Restoring and conserving tidal wetlands has considerable resilience, biodiversity, and social co-benefits in addition to these systems capturing and storing carbon. For instance, protecting and restoring mangroves can increase the resilience of coastlines to storms and flooding. Restoration can strengthen local communities' food systems and enhance their livelihoods. Protecting and conserving marine and coastal ecosystems is crucial for realizing the potential of these co-benefits.

While other ocean-related mitigation activities such as ocean energy and transport offer high mitigation potential, nature-based solutions (NBS) – such as coastal ecosystem protection and restoration or "blue carbon" – are a more cost-effective way of reducing greenhouse gas (GHG) emissions. Governments across the globe have started recognizing the value of blue carbon in their Nationally Determined Contributions (NDCs),[2] as have voluntary carbon markets (VCMs), which are becoming a source of financing for climate mitigation activities and have the potential to channel private sector finance at scale to nature conservation and restoration. However, in 2022 the number of blue carbon credits issued by Verra was still less than 1 million. With more projects in the pipeline, this number is expected to increase.

Carbon credits generated from blue carbon projects could be used by companies to offset residual emissions that cannot be achieved through emission reduction strategies or by governments to support their NDC commitments under the Paris Agreement Article 6.2 and 6.4 schemes. There is growing demand for blue carbon credits and rising awareness and interest in these types of projects.

The market is recognizing how influential these projects can be since they offer benefits to communities, while supporting biodiversity conservation and restoration and climate change mitigation and adaptation. Companies such as MSC Cruises and Apple have expressed interest in purchasing blue carbon credits.

Despite growing interest, coastal blue carbon projects are still in need of funding. Although capital for supporting these climate mitigation activities is available, it is slow in finding its way to viable projects. Carbon markets may improve this, as they have proved that they are able to quickly and efficiently mobilize funding to support climate mitigation activities.

When considering carbon markets as a financing solution for coastal ecosystems conservation and restoration, several other issues need to be considered. As with most nature-based carbon projects, blue carbon projects might face land tenure insecurity. Restoration costs vary among ecosystems and countries, and economies of scale still need to be achieved. There is also an opportunity to improve and revise existing carbon credit methodologies, which could scale up restoration efforts in blue carbon ecosystems.

This report serves to assess current market trends around coastal blue carbon with a view to identifying ways to boost financing for conserving and restoring marine and coastal ecosystems. This conservation and restoration work will contribute to mitigating climate change, while yielding co-benefits to affected coastal communities and other stakeholders and enhancing biodiversity.

1.2 Carbon markets

A carbon credit is a certified and transferable instrument representing one ton of CO_2 or equivalent GHG (CO_2e) that has been reduced, avoided, or removed. The terms "reduced" and "avoided" refer to decreasing CO_2 emissions to the atmosphere, while "removed" refers to capturing CO_2 from the atmosphere and storing it permanently. Carbon credits are created by climate change mitigation activities accounted for at the project, program, or jurisdictional level, and certified by carbon standards. Once created, carbon credits can be traded and ultimately retired to "offset" the equivalent volume of residual emissions by the holder of the credit and put towards a user's climate goals. Carbon credits must comply with strict criteria to ensure their integrity and quality. Key elements of a high-quality carbon credit include conservatively quantifying GHG emissions reductions or removals; credible baselines; accounting for leakage; following robust monitoring, reporting, and verification protocols; and assuring that the climate benefits are additional and permanent.

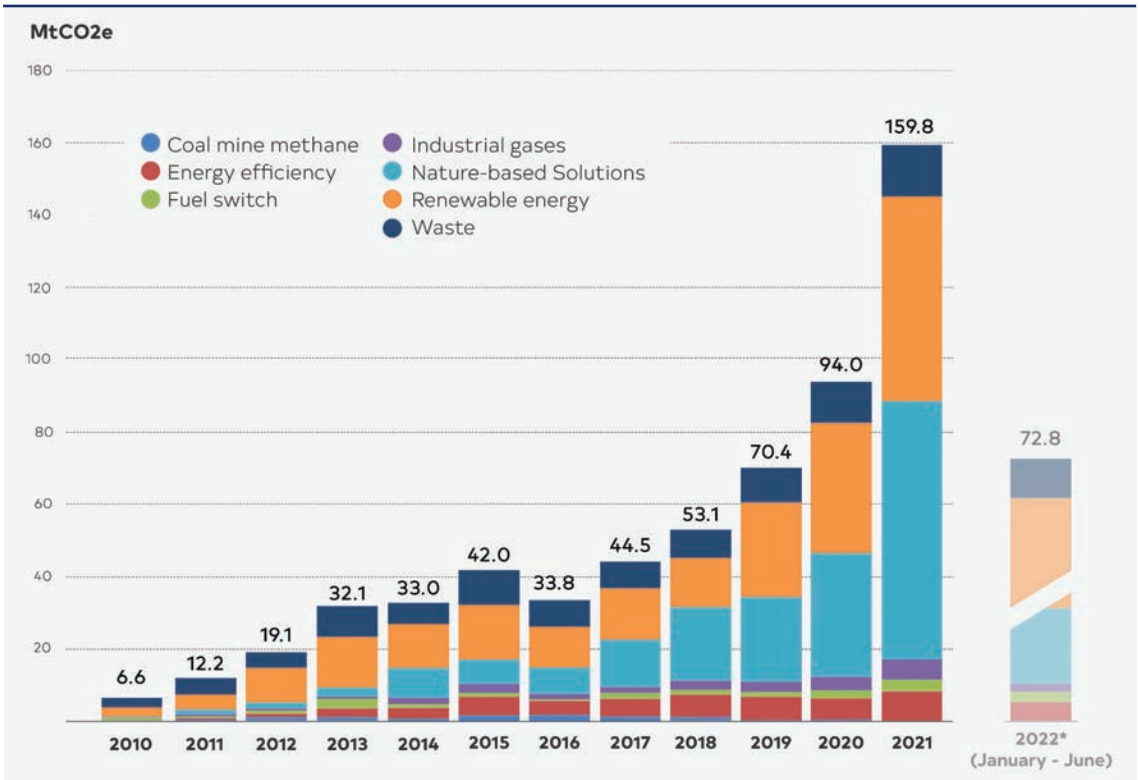
Projects and programs to reduce and remove GHG emissions are developed by private and/or public actors, and then registered by carbon standard organizations. Standards have been developed to ensure that the principles of additionality, permanence, and leakage are dealt with, lending credibility to the projects and to the carbon market. Most standards also require the use of independent auditors to assess a project.

State of voluntary carbon markets

Net-zero commitments by companies, cities, and other organizations more than doubled from 2021 to 2022, with 4,253 companies currently having a Science Based Targets initiative commitment or committing to have one by 2024.[3] Neutralizing residual carbon emissions and compensating for ongoing emissions are often part of the ensuing net-zero pathways. As a result, the value of VCMs grew by about 30 percent to $1.3 billion in 2022,[4] despite issuance of carbon credits falling by about 15 percent, although this drop was partially offset by the emergence of the first jurisdictional carbon credit issuances.[5] However, in 2022, retirements of carbon credits increased by 2 percent relative to 2021. In 2022, NBS and renewable energy projects accounted for about 75 percent of total credit issuances.

Development forecasts of VCMs vary widely, as they have different underlying assumptions. Trading dynamics are changing, led by companies with long-term commitments seeking ways to secure future offsetting needs.[6] Some estimates project that the volume of credits required to meet projected demand will increase between 20- and 40-fold from current levels in scenarios consistent with the Paris Agreement by 2035.[7] In September 2020, the Taskforce on Scaling Voluntary Carbon Markets estimated that the demand for carbon credits could increase 15-fold by 2030 to $50 billion.[8]

FIGURE 1: YEARLY VOLUMES OF RETIRED VOLUNTARY CARBON CREDITS[9]



Note: Includes retired voluntary carbon credits from VCS (Voluntary Carbon Standard), GS (Gold Standard), ACR (American Carbon Registry), and CAR (Climate Action Reserve).

Source: Climate Focus analysis of data collected for the VCM Dashboard (July 2022). Graphic drawn from Climate Focus. 2022. The Voluntary Carbon Market Explained.

Nature-based solutions in voluntary carbon markets

There are several definitions of NBS, but the one most commonly used is from the International Union for Conservation of Nature (IUCN): "Nature-based solutions are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits."[10]

The three main categories of NBS certified by VCM carbon standards are forestry, agriculture, and wetlands. The majority of NBS credits in VCMs come from the first category: forestry activities. These include avoided deforestation, afforestation/reforestation, and improved forest management. VCMs also incorporate reducing emissions from deforestation and forest degradation plus carbon stock enhancement (REDD+) through the certification and trade of carbon credits that are generated by projects and programs that seek to reduce deforestation. The second category, agricultural activities, includes regenerative agriculture, soil carbon sequestration, cover crops, reduced livestock emissions, agroforestry, and avoided conversion of grasslands.

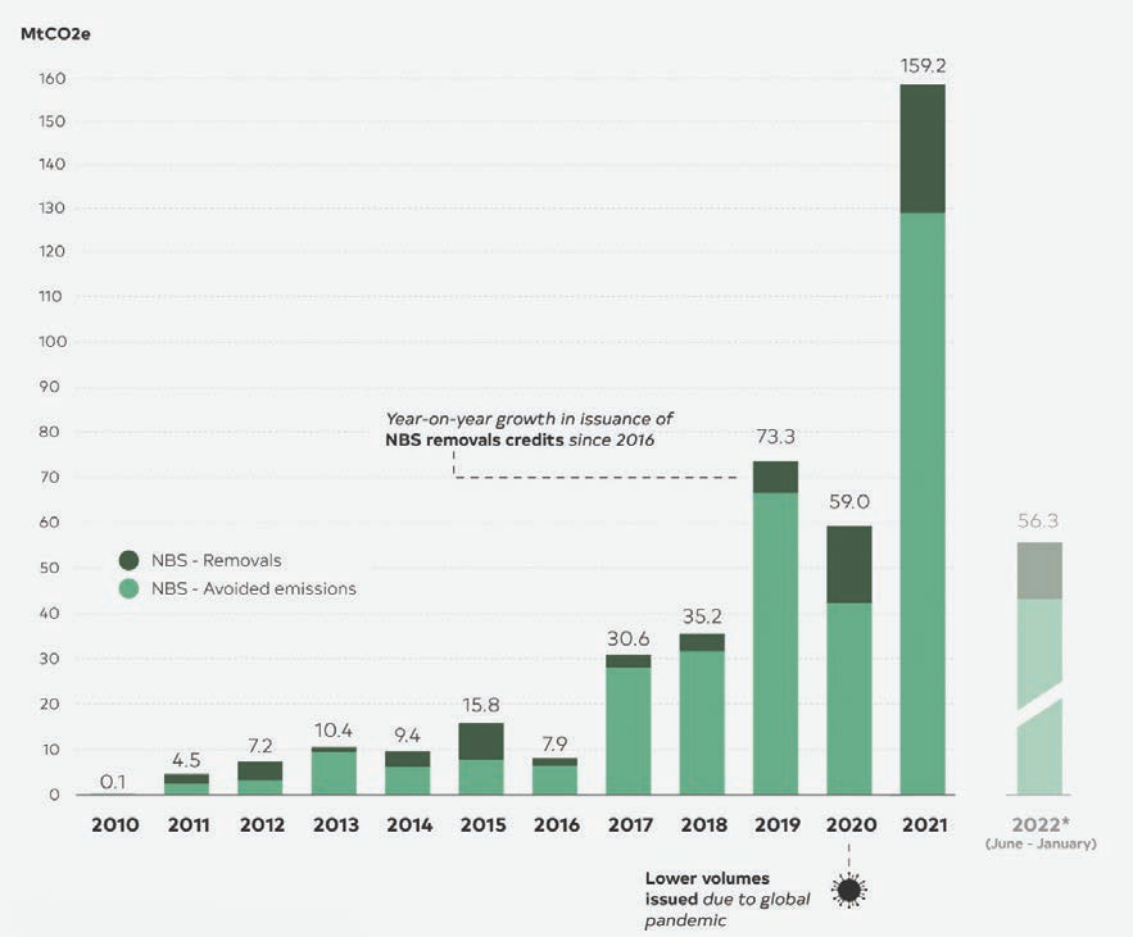
The third category, wetlands, includes freshwater and coastal areas. Wetlands make up a small percentage of the world's lands, yet they store more carbon per hectare of land than any other ecosystem. Thus, avoided impacts on and restoration of wetlands are important for climate change mitigation and adaptation actions. Activities that fall under wetland mitigation activities include avoided coastal impacts, coastal restoration, avoided peatland impacts, and peatland restoration.[11]

This report focuses on "coastal blue carbon," specifically tidal wetland restoration and conservation activities.

From January 2022 to February 2023, there were more than 4,340 registered projects across the different registries in the VCM. Of these, 534 fell into the category of NBS, representing 12.3 percent of total registered projects.[12] Nevertheless, carbon credits from NBS account for more than 35 percent of the credits issued between 2002 and February 2023, surpassing renewable energy projects in the volume of credits issued.

Issuance of carbon credits from NBS activities increased sharply in 2021, totaling 159 $MtCO_2e$. This represents a nearly threefold increase over the volume observed in 2020 (59 $MtCO_2e$).

FIGURE 2: NBS CARBON CREDITS ISSUED BY VCS, GS, ACR, AND CAR[13]



Note: VCS is Voluntary Carbon Standard, GS is Gold Standard, ACR is American Carbon Registry, CAR is Climate Action Reserve.

Source: Climate Focus. 2022.The Voluntary Carbon Market Explained.

The majority of NBS credits are generated from emissions reduction activities, particularly forest conservation. Although the issuance of removal credits has been on the rise, in 2021 only 17 percent of all NBS issuances came from carbon removal projects.[14] Afforestation/reforestation activities accounted for 20 $MtCO_2e$ or three-quarters of issuances from removal activities in 2021. In contrast, only 3 percent of carbon removal projects certified under Verra's Verified Carbon Standard (VCS) relate to wetland restoration and contribute 0.29 percent of credits issued in the market.[15]

Although prices vary per activity, the average price per ton for NBS credits was $4.33 in 2019, increasing to $5.66 in 2020 and falling to $4.73 in 2021.[16] In 2022, BNEF[17] listed the average price of an NBS (avoided deforestation) credit as $10.7. However, distinct activities command different prices. Mangrove restoration and afforestation/reforestation, in particular, can command prices of between $15 and $35 (based on observations in the market), reflecting price premiums due to sustainable development benefits.

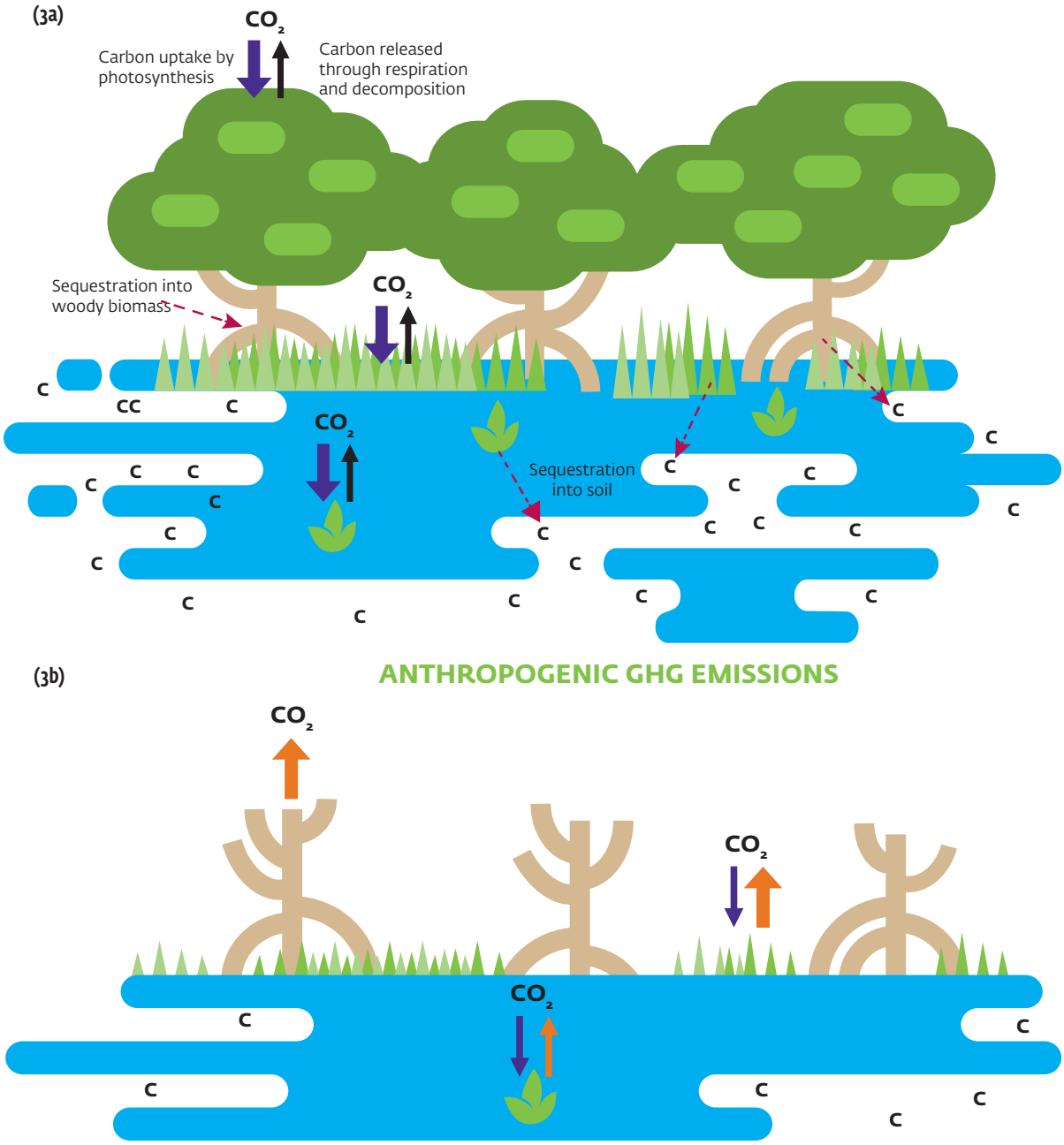
1.3 Blue carbon

The term "coastal blue carbon" is associated with tidal wetlands, particularly the management of mangroves, saltmarshes, and seagrass meadows. The term emerged around 2009 to describe this set of long-overlooked coastal ("blue") habitats. Although these ecosystems occupy a relatively small area (0.2 percent) of the global ocean, they are hotspots for carbon storage, as their soils sequester 10 times more carbon than terrestrial ecosystems.[18] Only about 1.5 percent of the world's blue carbon ecosystems are included in marine protected areas.[19]

When these ecosystems are degraded and converted, carbon in their biomass and soil, which has accumulated over an extended period, is oxidized and emitted back into the atmosphere in a matter of decades.[20] Studies estimate that around 0.2 gigatons (Gt) to 0.24 Gt of CO_2e are being released annually from conversion and degradation of these ecosystems. This represents between 3 percent and 19 percent of global deforestation, resulting in economic damages of $6 billion to $42 billion each year.[21]

Beyond their climate mitigation potential, these habitats provide essential ecosystem services such as fish, timber, fuelwood, coastal protection, pollution control, and cultural values for hundreds of millions of people who live in coastal areas.

FIGURE 3: UPTAKE, STORAGE, AND RELEASE OF CO_2 IN COASTAL WETLANDS



Note:
(3a) In intact coastal wetlands (from top to bottom: mangroves, saltmarshes, and seagrasses), carbon is taken up via photosynthesis (purple arrow) and gets sequestered long term in woody biomass and soil (red dashed arrows) or respired (black arrows).

(3b) When soil is drained from degraded coastal wetlands, the carbon stored in the soil is consumed by microorganisms, which respire and release CO_2 as a metabolic waste product. This happens at an increased rate when the soil is drained (when oxygen is more available), which leads to greater CO_2 emissions. The degradation, drainage, and conversion of coastal blue carbon ecosystems from human activity (for example, through deforestation and drainage, impounded wetlands for agriculture, and dredging) results in a reduction in CO_2 uptake due to the loss of vegetation (smaller purple arrows) and the release of GHG emissions (orange arrows). This is a unique trait of coastal blue carbon ecosystems compared to the other ecosystems discussed in the main text.

Source: Howard et al. 2017. "Clarifying the Role of Coastal and Marine Systems in Climate Mitigation." *Front Ecol Environ*.

Mangroves

Mangroves are a group of trees that grow in intertidal zones in tropical and subtropical latitudes around the globe. They are the only kind of tree that can tolerate salt water and excrete the excess salt through their leaves. Mangroves occupy 14.8 million hectares (ha) of coastal ground globally, with 5.4 million ha falling under protected areas. More than 40 percent of mangroves' global footprint is concentrated in four countries: Indonesia (19 percent), Brazil (9 percent), Nigeria (7 percent), and Mexico (6 percent).[22]

Often located on the boundary between land and sea, mangroves are among the most carbon-rich tropical forests, as they store and sequester comparatively high amounts of organic carbon in both biomass and soils. Mangrove soils contain up to 90 percent of mangroves' organic carbon stocks.[23] The most recent study to date of the soil carbon stored in mangrove forests estimates that mangroves have the capacity to store 6.4 Gt of carbon,[24] which is about two to four times as much as mature tropical forests,[25] and sequester more than 24 $MtCO_2e$ per year.[26]

Since 1980, between 20 percent and 35 percent of mangroves have been lost due to clearing for farming, aquaculture, and coastal development, among other factors. Deforestation hotspots can be found in South America and Southeast Asia, with deforestation in the latter region mostly driven by converting this ground for shrimp farming.[27] It has been estimated that between 2000 and 2012 about 317 $MtCO_2e$ was emitted as a result of mangrove deforestation. Although deforestation rates have declined in the past decade, mangrove conversion emits almost 14 $ktCO_2$ per year.[28]

Mangroves have also been degraded due to urbanized coasts. The construction of sea walls and roads on a coastline affects the hydrologic regime of that area. This has implications for the current sea level and future rises in sea level, which in turn affects mangrove conservation efforts.

Sea level rise has been identified as the most significant climate change factor affecting mangrove distribution[29] and carbon stocks. However, degradation has been more challenging to measure and could lead to incorrect assessments of appropriate conservation initiatives.[30]

Saltmarshes

Saltmarshes are formed by the accumulation of mineral sediments and organic material, which are then flooded with tidal waters. Their soil, which can be several meters deep, contains almost all the carbon in saltmarsh ecosystems. Saltmarshes filter pollutants, which contributes to good water quality in coastal areas. They are also critical habitats for many marine species and are essential for healthy fisheries.

Saltmarshes have not been systematically mapped globally, yet some estimates show that they cover around 5.5 million ha.[31] Saltmarshes are found mainly outside of the tropics, with substantial coverage found in the United States (1.7 million ha), Canada (1.1 million ha), Europe (356,947 ha), and Australia (1.3 million ha). In emerging markets, countries with extensive saltmarshes include Argentina (118,870 ha), Mexico (272,527 ha), and Russia (700,719 ha). In Southern Brazil and Uruguay (37,858 ha) there are extensive marshes within estuaries. China once had extensive areas of saltmarshes, but more than 95 percent of these have been converted to accommodate rice, aquaculture, and development.

It is estimated that the average annual carbon sequestration rate for saltmarshes is between 6 tCO_2e and 8 tCO_2e per hectare. Emissions from converted saltmarshes can be prolonged, with emission patterns resembling those of peat forests, where emissions continue for decades, if not centuries, after initial conversion to agriculture. For example, emissions from the drained agricultural soils of Sacramento-San Joaquin Delta have been continuing for over a century.[32] Global rates of saltmarsh loss are estimated to be between 1 percent and 2 percent per year, resulting in estimated emissions of between 0.02 $GtCO_2e$ and 0.24 $GtCO_2e$ per year.[33]

In most industrialized countries, saltmarshes are heavily degraded. The installation of levees, train tracks, and roads have severed their connection to the sea and altered the hydrology. Apart from draining and filling, saltmarshes are diked, grazed, harvested for fodder, and otherwise used for agriculture.

Seagrass meadows

Seagrasses are underwater flowering plants that accumulate carbon in their deep roots, which grow up to four meters long. As a coastal ecosystem, seagrasses play a significant role in supporting food security, combating climate change, enriching biodiversity, purifying water, and protecting coastlines. Seagrass meadows are often largest in estuaries and bays where harbors and cities are conjoined. Although seagrasses only cover 0.2 percent of the seafloor, they can store up to twice as much carbon per hectare as terrestrial forests and are responsible for 10 percent of all carbon buried annually in the sea.[34] Some estimates suggest that some 946 seagrass meadows spread across the globe could potentially store up to 8.4 $GtCO_2e$.[35]

Studies have estimated that meadows cover an area of between 16 and 26 million ha,[36] but it is difficult to make an accurate estimate as large areas of seagrass are unmapped and inconsistent measures are being used. The World Atlas of Seagrasses[37] highlights Australia as having the most extensive area (9,630,000 ha), followed by Indonesia (3 million ha) and the Gulf of Mexico (1,934,900 ha).

Seagrasses are among the most threatened and least conserved marine ecosystems. Only 26 percent of recorded seagrass meadows are in protected areas.[38] It is estimated that 29 percent of global seagrass ecosystems have been lost, that the rate of loss each year is 1.5 percent, and that degradation of these ecosystems contributes to emissions of 0.05 to 0.33 $GtCO_2e$ per year.[39]

Seagrasses are subject to many threats, including runoff of nutrients and sediments, boating, land reclamation, dredge-and-fill activities, and destructive fisheries practices. Climate change will also affect seagrasses as sea levels rise and severe storms become more frequent.

Tidal wetland conservation and restoration

Recent studies estimate that protecting existing coastal ecosystems (mangroves, saltmarshes, and seagrass meadows) could contribute to the mitigation of 0.2 to 0.35 $GtCO_2e$ per year of emissions and that restoring these ecosystems could offer an additional 0.2 to 0.85 $GtCO_2e$ per year of sequestration between now and 2050. Thus, the total potential mitigation contribution from coastal ecosystems is estimated to be between 0.5 and 1.38 $GtCO_2e$ per year by 2050.[40] For example, studies have found that up to 666,500 ha of degraded mangroves could be restored and that they have the potential to sequester up to 69 $MtCO_2e$.[41]

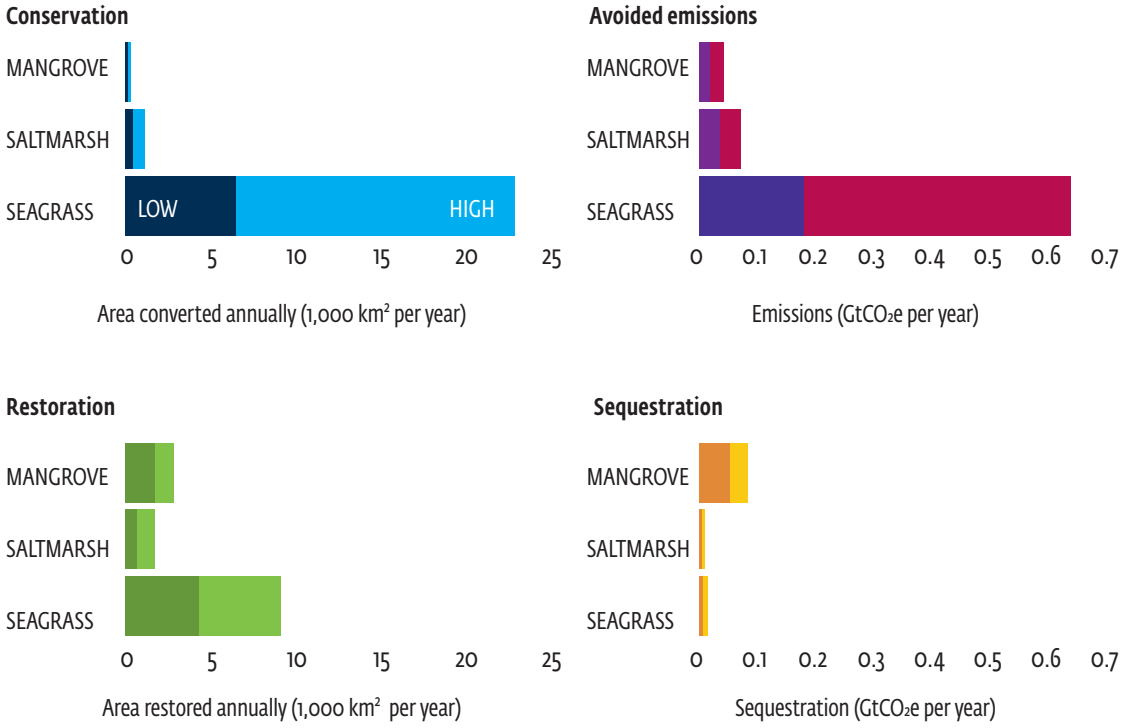
Blue carbon solutions focus on two main climate mitigation options: (1) conserving and protecting coastal ecosystems, and (2) restoring degraded blue carbon ecosystems. Conservation involves halting loss and degradation of the ecosystem, and directly changing land use. Protection on a per unit area basis offers high emissions reductions benefits because of the density of carbon stocks in their biomass and particularly in their soils. Restoring degraded blue carbon ecosystems is more complex and could require a suite of activities, but mainly involves rehabilitating the soil and associated organisms and restoring their ability to sequester carbon. These activities aim to address the root causes of loss – for instance, by restoring water quality by reducing pollution and nutrient runoff, encouraging water circulation by removing dams that drain saltmarshes, and actively restoring and assisting natural regeneration through mangrove seeding or planting interventions.[42]

Although mangroves and seagrasses contribute equally to avoided emissions potential through protection of the existing habitat, mangroves contribute the largest proportion to climate mitigation potential from the restoration of disturbed or lost habitats.[43] However, not all lost ecosystems can be restored. One study shows that 17 percent of the 973,640 ha of mangroves lost between 1996 and 2016 is not restorable due to urbanization, erosion, and high restoration costs.[44]

Thus, costs vary substantially among conservation and restoration projects, given that activities in the latter differ considerably and usually have longer time frames. Whereas conserving remaining blue carbon ecosystems can be a cost-effective way of reducing GHG emissions, restoration requires substantial investments.

Restoring blue carbon ecosystems on a large scale is potentially feasible for mangroves and saltmarshes, but is challenging for seagrass meadows.[45] Compared to other marine ecosystems, seagrass restoration is a more complex and costly activity with historically lower success rates, as their natural restoration is a very slow process.[46] Yet it is possible, as shown by the world's largest seagrass restoration project in Virginia, where it took researchers and volunteers two decades to spread more than 70 million seeds to bring back eelgrass and restore 3,600 ha of degraded seagrass.[47] Restoration and conservation measures are effective for ensuring the long-term survival of a blue carbon ecosystem, but depend on numerous factors.

FIGURE 4: COMPARISON OF THE ESTIMATED MITIGATION POTENTIAL OF THE CONSERVATION AND RESTORATION OF COASTAL WETLANDS



Source: Ove Hoegh-Guldberg et al. 2019. "The Ocean as a Solution to Climate Change: Five Opportunities for Action." World Resources Institute, pg. 50.

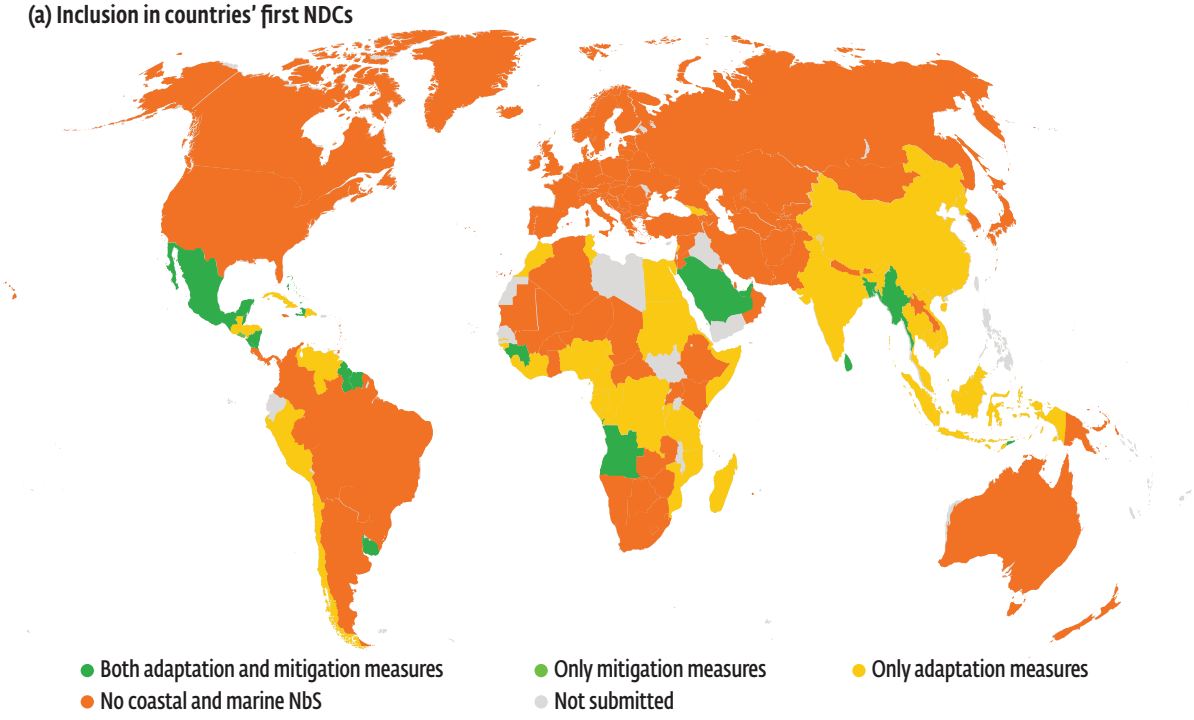
Tidal wetland restoration in NDCs

In 2013, the Intergovernmental Panel on Climate Change provided methodological guidance for estimating emissions and removals of carbon from mangrove, seagrass, and saltmarsh ecosystems to promote their conservation and protection. These guidelines are intended to provide countries with technical guidance on the ways in which coastal wetlands can be included in updated NDCs to the Paris Climate Agreement.

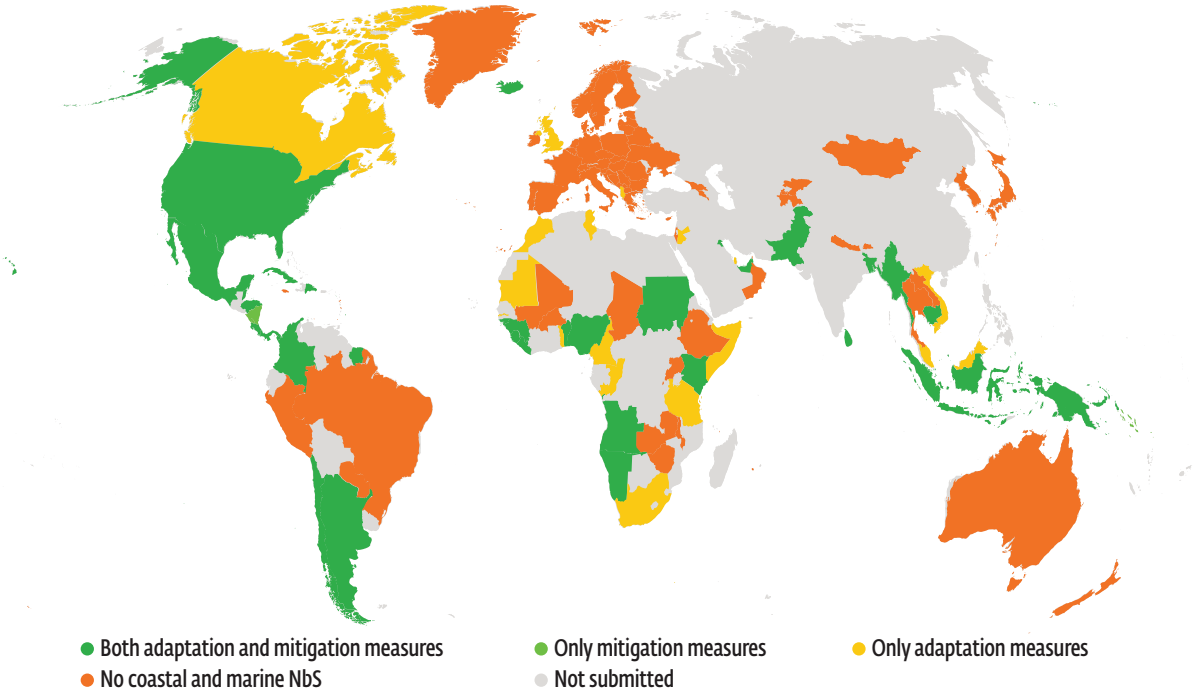
As of 2021, 71 of 118 countries that submitted their NDCs included coastal and marine ecosystems, with 45 countries including coastal and marine ecosystems for both mitigation and adaptation purposes.[48] These ecosystems are mostly protected through the expansion of protected area status – national parks, recognized conservation areas, and marine protected areas.

FIGURE 5: INCLUSION OF COASTAL AND MARINE NBS FOR MITIGATION AND/OR ADAPTATION IN SELECTED COUNTRIES' NDCS

(a) Inclusion in countries' first NDCs



(b) Inclusion in countries' updated NDCs



Note: Indonesia, Brazil, and Mexico are major mangrove countries (with thus far low blue carbon consideration). Belize, the Seychelles, and Cape Verde are small island developing states with clear blue carbon interest. Chile and Costa Rica have integrated innovative approaches to NBS in their NDCs and are therefore listed for comparison.

Source: Lecerf, M., Herr, D., Thomas, T., Elverum, C., Delrieu, E., and Picourt, L. 2021. Coastal and Marine Ecosystems As Nature-Based Solutions in New or Updated Nationally Determined Contributions. Ocean & Climate Platform, Conservation International, IUCN, GIZ, Rare, The Nature Conservancy, Wetlands International, and WWF.

Mangroves are implicitly or explicitly included under several international conservation policy mechanisms, including the Ramsar Convention on Wetlands and the Convention on Biological Diversity. Mangroves have received particular attention as a blue carbon-based climate change mitigation opportunity because of threats in tropical regions and their potential to be incorporated into REDD+ programs.

Depending on a country's national forest definition, mangroves may be included in its overall forestry-related activities, including REDD+, and in its GHG inventory under land use, land-use change, and forestry activities. The Food and Agriculture Organization and REDD+[49] are leading efforts to help countries include mangroves in national REDD+ strategies as part of their commitments under the Paris Agreement. Including mangroves-based mitigation action in national REDD+ strategies involves identifying specific policies and actions to address, and where possible reverse, the drivers of deforestation and forest degradation, and to increase forest cover. However, there is great variation in how countries incorporate mangroves in their REDD+ strategies. For example, Costa Rica and Indonesia cover mangroves in their Forest Reference Level but do not include mangroves' below-ground biomass and soil carbon components.[50]

In contrast, saltmarshes and seagrasses are not included in any REDD+ programs or, it appears, in any other government-driven results-based finance framework. Although seagrasses and saltmarshes are valuable ecosystem service providers, they have often been marginalized or missing from the global conservation agenda.

Beyond the NDCs, flagship initiatives focusing on tidal wetlands have emerged in different parts of the world. These include Senegal's aim to restore 4,000 ha of mangroves, Costa Rica's commitment to restore 80 percent of the mangroves at the Gulf of Nicoya, Papua New Guinea's commitment to include blue carbon ecosystems in its GHG inventory, Sri Lanka's program to restore 25 percent of its wetland landscapes, and the Seychelles' adoption of a debt-swap strategy to fund its conservation and protection activities.[51]

Environmental and social benefits of restoring tidal wetlands

An important aspect of blue carbon ecosystem restoration and conservation, and NBS more broadly, is that, beyond their potential for carbon sequestration and storage, they come with a wide range of other ecosystem services such as nutrient removal, fisheries enhancement, and coastal protection. They offer recreational, tourism, and additional livelihood opportunities for local communities. When estimating ecosystem services, it is important to recognize that not all coastal ecosystems are structurally and functionally equal, as their levels of connectivity influence the level of the various benefits they provide.[52]

Mangroves' environmental and social contributions are best understood as they are the most studied of the blue carbon ecosystems. The establishment of mangrove protected areas has been associated with long-term gains in fisheries production. Mangroves are increasingly valued for their contribution to protecting communities from the impacts of tropical storms and cyclones.

Seagrasses provide supportive conditions for other marine habitats and fisheries. Furthermore, as waves travel over the seagrass canopy, the flexible seagrass leaves reduce wave energy and stabilize the sand on the seafloor. In doing so, seagrass meadows protect the beach foreshore slope from erosion.[53]

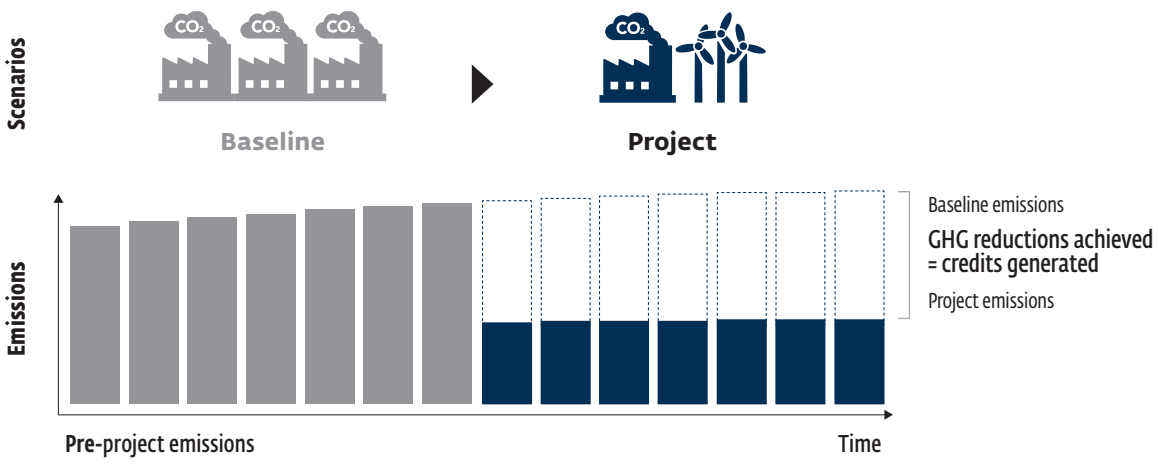
Saltmarshes also offer a suite of ecosystem services such as nutrient cycling, fisheries enhancement, coastal protection, and recreational opportunities.[54] Like seagrasses, their physical structure reduces wave energy and traps sediments as well as providing refuge for fish.

Given that coastal ecosystems offer both mitigation and adaptation benefits for nearby communities, protecting and restoring them is a way for countries to increase their structural and economic resilience to the effects of climate change.

1.4 Blue carbon project development

As mentioned in the previous section, carbon standards issue carbon credits to registry accounts using an approved protocol and methodology. Carbon credits are generated through a baseline-and-credit system that compares actual GHG emissions to a counterfactual baseline scenario, accounting for reductions and removals that would not have occurred in a business-as-usual scenario. The standards then require that the credit-generating project or program demonstrates that the reductions or removals would not have happened in the absence of the project, thus confirming that the project is additional. For all blue carbon projects, Verra deploys a so-called standardized approach to additionality, which means that all project activities complying with Verra's tidal wetlands methodologies are deemed additional. This has been based on a global study showing a penetration rate of less than 5 percent: that is, only a very small fraction of investment needs for tidal wetlands restoration and conservation is being met worldwide.

FIGURE 6: CALCULATING EMISSION REDUCTIONS COMPARED TO A BASELINE



Source: Climate Focus. 2022. The Voluntary Carbon Market Explained.

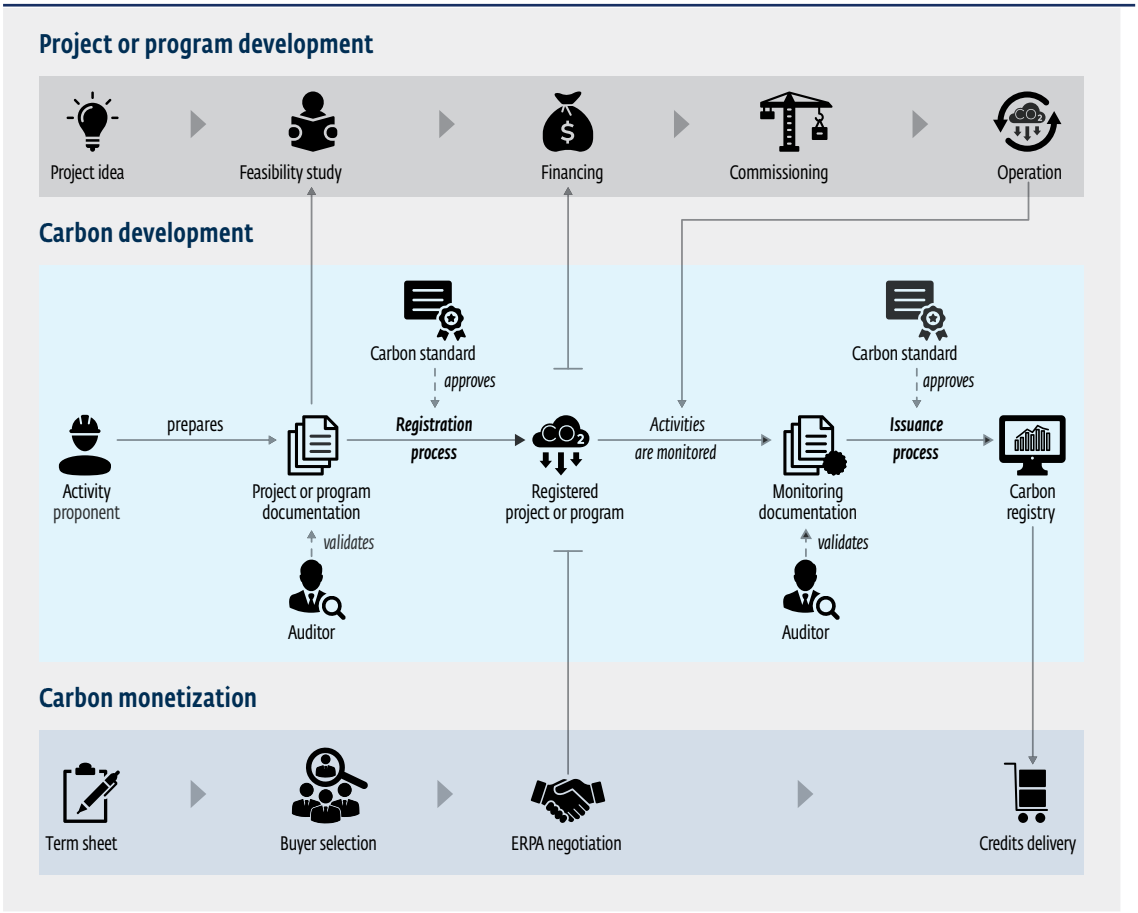
National policies and regulations must be considered when developing a project or program baseline and testing the project's additionality, confirming that there are not already interventions providing similar incentives to credit-generating projects. For jurisdictional programs, some standards require governments or administrative jurisdictions to deploy additional measures against a jurisdictional baseline.

Carbon project development cycle

The process through which VCM projects or programs are designed, climate benefits are generated, and carbon credits are issued and traded is called the carbon project or program cycle.

Figure 7 shows in more detail the three parallel processes of the carbon project cycle: project development, carbon development, and carbon monetization. Comprehensive guidance documents and manuals for carbon project development in land use have been widely published[55] and standards focusing on projects (for example, Verified Carbon Standard and Gold Standard) and jurisdictional programs (such as Jurisdictional and Nested REDD+ and Architecture for REDD+ Transaction ART/TREES) follow similar steps.

FIGURE 7: CARBON PROJECT DEVELOPMENT CYCLE



Source: Climate Focus. 2022. The Voluntary Carbon Market Explained.

During **project development**, private or public proponents of mitigation activities plan their projects. If they haven't already done so, the proponents familiarize themselves with relevant aspects of carbon projects and formulate a concept. Relevant stakeholders are identified, after which a feasibility study is done to assess technical and financial feasibility, permits, and support from stakeholders. Thereafter, the project proponents look to finance the project, followed by constructing, commissioning, and implementing the project.

In parallel, project proponents **develop the carbon asset** of the project. They prepare the project or program document according to the guidelines of the carbon standard under which they wish to be certified to initiate the **carbon development phase**. In this document, project proponents apply approved methodologies to demonstrate the additionality of the project, establish an emissions baseline or reference level, propose monitoring procedures, identify leakage, and in the case of land-use projects, address permanence risks. The project document is validated by an external auditor before the carbon standard registers the project as a carbon project. During implementation of the project, the project proponent monitors emission reductions or removals at regular intervals. After further verification by an external auditor, the carbon standard can issue the carbon credits[56] from the carbon registry.

The project and carbon development processes are completed with the **monetization of the carbon credits.** Until recently, most carbon credits in the voluntary carbon market were exclusively sold over the counter (OTC), meaning that carbon credit sales are negotiated privately between a buyer and seller. These sales are usually documented through an Emission Reduction Purchase Agreement (ERPA) that specifies the terms of the transaction, including the volume of carbon credits to be sold, delivery dates and modalities, price, eventual prepayments or other financial support by the buyer, and other details. Although voluntary carbon markets are still relatively nascent, recent rising demand has increased liquidity. This has facilitated more options for buyers and sellers, including the ability to sell credits through forward sales contracts (as opposed to spot contracts) and transact on a growing number of exchanges (as opposed to OTC).

Blue carbon standards and methodologies

Carbon project interventions in blue carbon ecosystems account for both removals (for example, through restoration practices) and avoidance (for example, through conservation of coastal ecosystems) of GHG emissions. The Verified Carbon Standard (VCS, managed by Verra) is by far the largest standard in the agriculture, forestry, and other land use (AFOLU) sector, with the most projects registered, the most carbon credits issued, and the most comprehensive coverage of AFOLU project types of conservation and restoration of blue carbon ecosystems. Some of the GHG accounting procedures for blue carbon interventions are quite similar to those for forestry projects, such as assessing baseline scenarios, carbon stocks in biomass, and leakage emissions from activity shifting. But specific components are distinctly different when assessing other dynamics, such as the effects of sea level rise (as the tidal zone may shift landward), ecological leakage (changes to adjacent areas due to hydrological connectivity), carbon stocks in tidal wetland soils, and methane emissions.

The VCS has two global methodologies: VM0033 (Methodology for tidal wetland and seagrass restoration) and VM0007 (REDD+ Methodology Framework), which include tidal wetlands modules. The latter covers all functionality of VM0033, which focuses on both restoration and conservation activities. Under VM0033, additionality is addressed using a standardized method involving a so-called positive list, which implies that projects meeting the applicability conditions of this methodology are deemed additional. Following an attempt by Verra to harmonize baseline accounting procedures across all its REDD+ methodologies, the baseline accounting procedure of VM0007 will be subject to changes after expert review.

In a further attempt to capitalize on the increasing interest in blue carbon methodologies and lessons learned from years of practice, Verra, in collaboration with Silvestrum Climate Associates, has chosen to make VM0033 the all-encompassing blue carbon methodology, covering both restoration and conservation practices. The updated VM0033 will adopt the new REDD baseline principles and procedures in the all-new VCS afforestation, reforestation, and revegetation methodology (currently under validation). The new methodology (VM0033 v3) is expected to be available in 2023, with tidal wetlands procedures removed from VM0007.

Certain jurisdictions such as Louisiana (United States) , and Australia have their own GHG accounting methodologies for tidal wetlands, but these are used to a lesser extent. Australia has included blue carbon ecosystems in its national GHG accounts. The Australian government's Emissions Reduction Fund has developed comprehensive guidelines for that purpose.[57] In Japan, guidance documents have been prepared describing measurement methods for seagrass meadows, tidal flats, embayments, and port facilities.[58]

As shown in Table 1 (Annex – Overviews), most currently registered mangrove restoration projects have previously applied AR-AM0014 (Afforestation and reforestation of degraded mangrove habitats), which is a Clean Development Mechanism (CDM) methodology. Verra announced in June 2022 that it would disallow new projects using the CDM afforestation/reforestation methodologies (including AR-AM0014) as it considers these methodologies to be uncompliant with the VCS.[59]

Another program for blue carbon projects is Plan Vivo, which targets community-led projects that involve rural smallholders and communities dependent on natural resources for their livelihoods. It currently has three approved approaches to issue certificates. Until recently, Plan Vivo would certify projects that submitted their own or a Plan Vivo-approved approach to estimate climate benefits. This is now being revised, and projects will need to meet the methodology requirements when they become available.[60]

2.

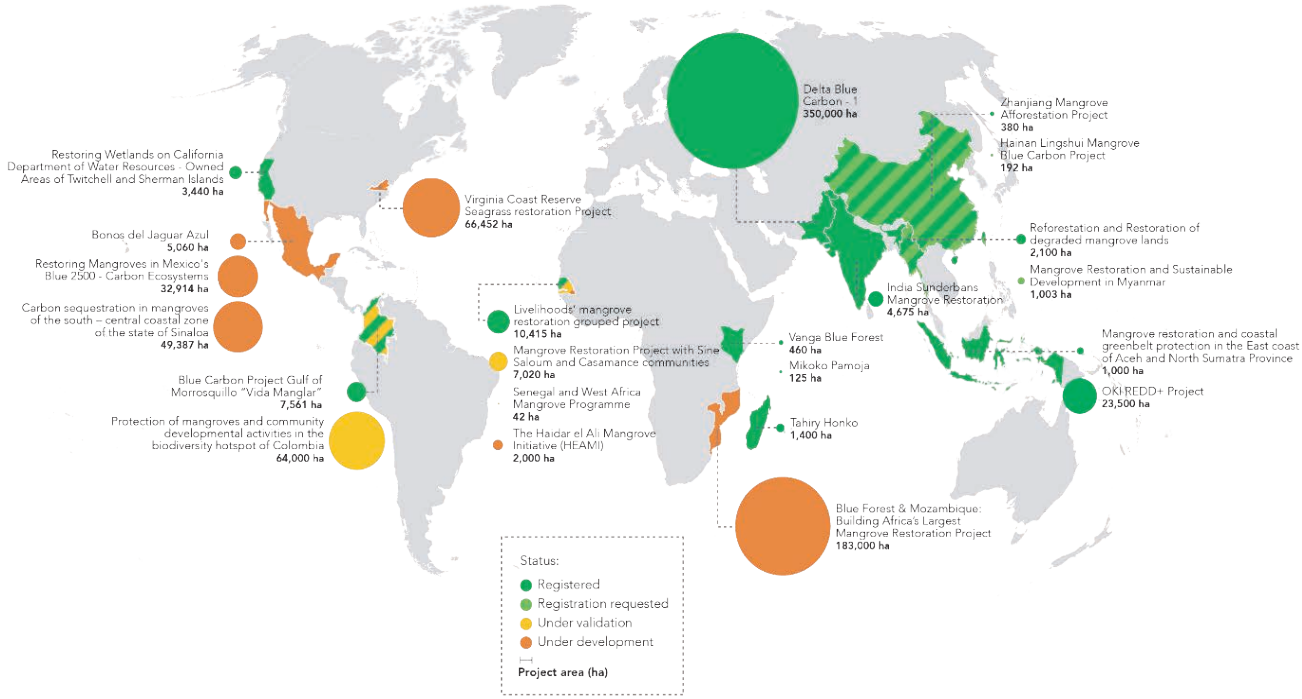
Project Potential

2.1 Blue carbon projects in the voluntary market

Number and scale of projects

Figure 8 and Table 1 provide an overview of the blue carbon projects registered as of June 2022 and the ones listed as under validation or under development. Verra (VCS) has the most projects registered or in the pipeline (20 out of 24). Plan Vivo has three and ACR just one.

FIGURE 8: BLUE CARBON PROJECTS AS OF JUNE 2022



Source: Verra and Plan Vivo registries.

Most projects involving mangrove restoration use the recently disallowed AM0014 methodology.[61] There is one registered mangrove conservation project of moderate size under the VCS, while Plan Vivo has two small conservation projects.

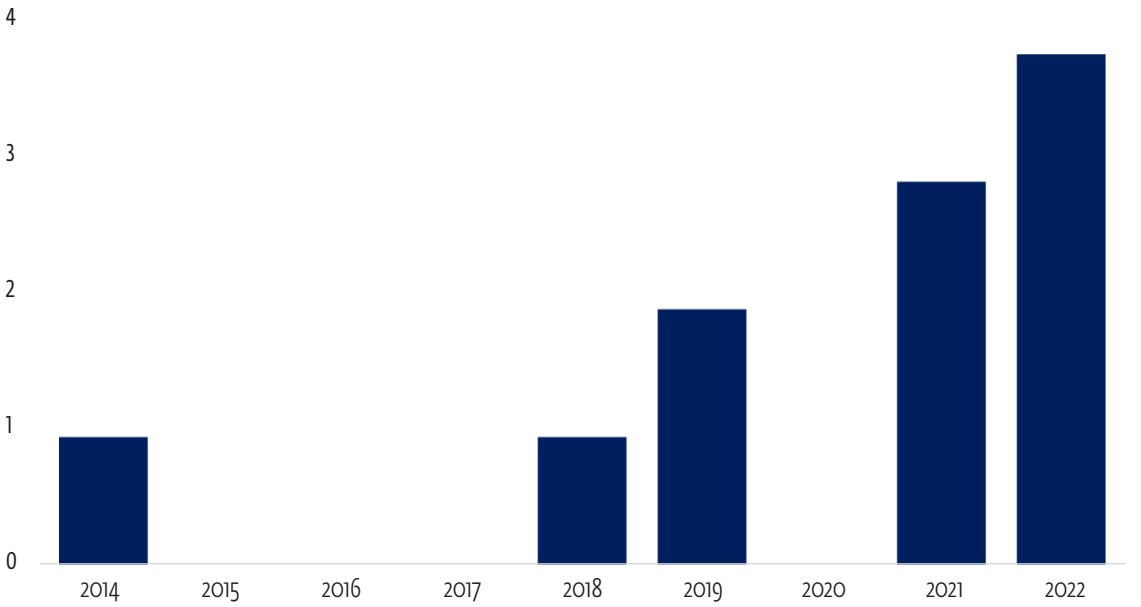
As scale matters for NBS, the size distribution is conspicuous. There is only one very large-scale project in Pakistan (224,000 ha) and eight moderate- to large-scale projects (more than 10,000 ha) elsewhere. Of the smaller projects, 10 are around 1,000 ha or less. This shows that there is bias towards smaller projects. Projects like the one in the Indus Delta in Pakistan (DBC-1) are unlikely to be repeated in other parts of the world for two main reasons: the sheer size of restorable area is unprecedented and the relatively simple institutional setting favors implementation at scale.

Blue carbon as a nature-based solution will require more smaller steps rather than a few big ones. Blue carbon ecosystems and drivers of degradation are commonly smaller in scale. Of the 23 blue carbon projects known to the carbon standards (see Table 1 in the annexes), 13 are expecting to generate less than 50,000 tCO_2e of carbon credits per year, whereas only three have a scale of over 1 million tCO_2e per year. The latter is the scale that would be attractive to many big carbon buyers. Overcoming the small scale of many projects would require bundling or grouping them to benefit from economies of scale. However, grouped blue carbon projects have not yet been presented under the VCS.

Rate of uptake

Under the VCS, the first blue carbon project was registered in 2014, followed by one in 2018, two in 2019, and three in 2021. Currently (2022) there are four projects under validation or that have requested registration, which shows that the pace is increasing (Figure 9).

FIGURE 9: BLUE CARBON PROJECTS REGISTERED UNDER THE VCS



Note: The data for 2022 only includes projects under validation or requesting registration, but these are likely to be registered.

Source: Climate Focus analysis of data collected for the VCM Dashboard (July 2022).

2.2 Coastal blue carbon potential

To date, blue carbon has focused on mangroves, saltmarshes, and seagrass meadows – that is, "coastal blue carbon." The emerging extension of blue carbon involves the restoration of seaweed ecosystems and the creation of large-scale seaweed farms, as well as seafloor management, for example, by avoiding bottom trawling. While the science on coastal blue carbon has been developed over the past decade and supports the implementation of these blue carbon projects, the latter category still has significant uncertainties. This report therefore focuses on coastal blue carbon.

Mangroves, saltmarshes, and seagrass meadows (restoration and conservation) together have the potential to offset 0.5 to 1.38 $GtCO_2$ per year (mangroves: 0.06 to 0.73 tCO_2/year; saltmarshes: 0.07 to 0.1 tCO_2/year; seagrass: 0.28 to 0.37 tCO_2/year).[62] It has been estimated that these would be viable at less than $18 per tCO_2, in the range of current prices paid in the voluntary carbon markets but well below prices paid in the EU Emissions Trading Scheme, which are trading at around €80 to €90. Emerging oceanic blue carbon could potentially offset another 1.8 $GtCO_2$ per year.[63]

The current set of registered and pipeline projects in Table 1 expect to realize estimated emission reductions of some 11 million tCO_2 per year if they are fully implemented, which is likely to still take several years to a decade. This is a factor 100 below the potential of this category. This shows that the blue carbon market is still in its infancy. In 2020, Verra issued 0.3 million blue carbon credits – a fraction of the 32.4 million AFOLU credits. Nonetheless, its issuance of blue carbon credits has grown, tripling from 0.3 million in 2020 to 0.97 million in 2022.

2.3 Near-future developments

Blue carbon projects developed in the past decade benefited from relatively favorable conditions such as the involvement of a willing local community and government, and low implementation costs. There remain areas where blue carbon projects could benefit from similarly favorable conditions such as restorable areas where ecosystems have become degraded due to natural disturbance and where there is no competition for land use. There are also opportunities for conservation, in particular where tidal wetlands are owned by the government and conservation can be pursued.

The uptake of mangrove conservation has been limited so far. With mangrove restoration, the baseline is relatively clear, operating procedures are relatively simple, and market acceptance is relatively high due to the simple relationship expressed as "more forest, less CO_2." In comparison, mangrove conservation involves more complex conditions on the ground, inconsistent and criticized baseline accounting protocols, and a greater dependency on jurisdictional frameworks. Conservation through livelihood improvement and local markets (for example, avoiding unplanned wetland degradation by local communities) is more complicated as they are developed from the bottom up by nongovernmental organizations. However, they do have an appeal to carbon markets as their co-benefits can be monetized – for example, via an additional climate, community, and biodiversity certification by Verra.

As discussed in section 1.3, restoration costs on a per hectare basis vary enormously. Across the tropical belt, mangrove ecosystems have been degraded on a large scale as a result of infrastructure works that impede tidal flow. Restoring these tidal wetlands requires infrastructure to be removed or converted to tide-friendly structures, with associated high costs. In some countries (such as Mexico) project developers are carrying out feasibility assessments of these kinds of projects, where blended financing is a consideration.

Table 1 shows one seagrass restoration project, but such projects are mostly in a research and proof-of-concept phase. Restoring seagrass beds is a technically challenging undertaking, while revenues in terms of CO_2 removals on a per hectare basis are limited. Seagrass conservation would be a more favorable proposition due to the large carbon stocks in the soil were it not for the challenge of quantifying baseline degradation rates and suboptimal conditions for remote sensing. Seagrass conservation has great potential as a blue carbon solution given the large area it covers globally and the significant threats it is exposed to.

3.

Carbon Pricing

3.1 Carbon price development

Based on market analysis, Climate Focus expects the recent surge in carbon prices to continue, from $15 to $24 in 2022 to $40 to $65 in 2040. Blue carbon projects could fetch prices at the higher end of these ranges. The starting point for the price forecast lies in our estimates of future annual supply and demand.

The **supply of carbon credits** comes from currently registered climate mitigation activities under the carbon standards. Future supply will come from these activities and from those currently under development or validation.

The **demand forecast** considers three sources of demand and their evolution over time. The first and most relevant source of demand for carbon removal credits (that is, blue carbon, afforestation/reforestation, carbon sequestration in agriculture, and some improved forest management activities) is the voluntary demand from corporates aiming to move to a net-zero carbon trajectory or become carbon neutral. These commitments are driven by initiatives such as the Science Based Targets initiative (SBTi) for target setting, the CDP for reporting, or the Financial Stability Board's Task Force on Climate Change for disclosure. Under the guidance of these initiatives, companies are seeking carbon credits to neutralize any emissions remaining after their production processes and supply chains have been decarbonized.

The second source of demand is global sectoral initiatives, such as the International Civil Aviation Organization's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and the International Maritime Organization.[64]

The third source of demand is carbon pricing schemes, such as carbon tax schemes that allow companies to partially offset their tax obligation through offsets (for example, Colombia and Mexico) and emissions trading schemes that allow for the use of international offsets (for example, the Republic of South Korea).

As in any other market, there is a great deal of uncertainty about what future demand and supply will look like, which will ultimately drive the price of carbon credits. This uncertainty is triggered by a set of demand- and supply-side risks, outlined in Table 4 in section 6.3.

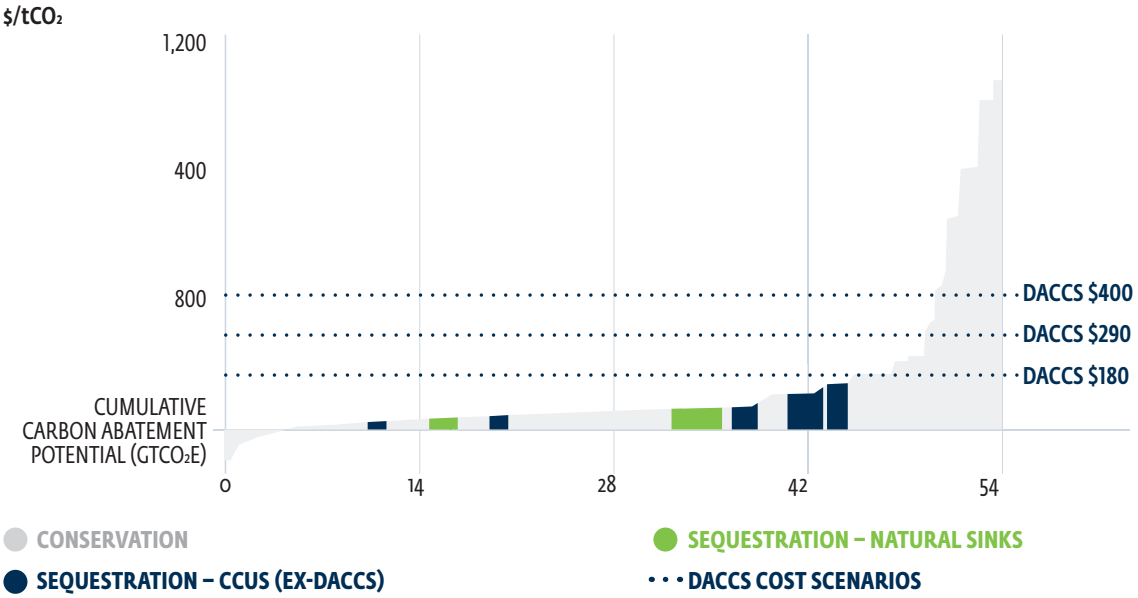
Pricing trajectories

The prices that can be expected for credits from blue carbon projects are considerably higher than the prices paid for credits using a generic REDD+ results-based finance approach (where prices range between $8 and $10). Mangrove restoration and afforestation/reforestation, in particular, can command prices of between $15 and $35 per credit (based on observations in the market) plus potential premiums due to sustainable development benefits.

Energy-intensive industries and industries with a longer transition period (due to current lack of low-carbon technologies) are entering the market and paying competitive offset prices for sequestration credits as their internal marginal abatement costs are high. According to Goldman Sachs (see Figure 10), through decarbonization technologies such as carbon sequestration, renewable power, and clean hydrogen, about 60 percent of GHG emissions can be removed at less than $100 per ton of carbon. In contrast, sequestration through natural sinks can be achieved at more competitive prices.

FIGURE 10: TOTAL CONSERVATION AND SEQUESTRATION COST CURVE BASED ON CURRENT TECHNOLOGIES AND ASSOCIATED COSTS

Cumulative carbon abatement potential ($GtCO_2e$)



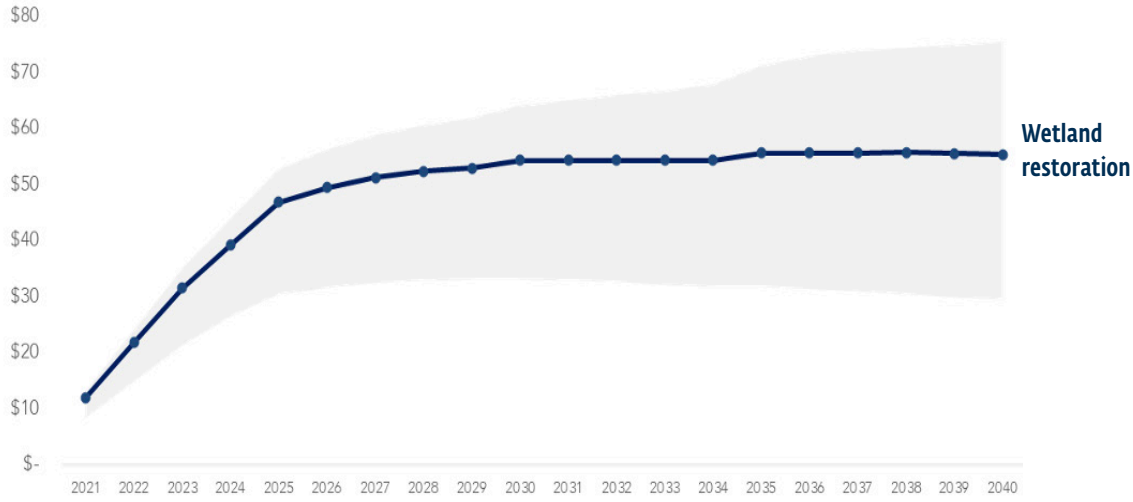
Note: CCUS is carbon capture, use, and sequestration. DACCS is direct air carbon capture and storage.
Source: Goldman Sachs and Brookfield. 2021. "Powering the Transition to NetZero." *Goldman Sachs Global Investment Research and Brookfield Insights*.

Since 2020, several large companies – including Microsoft, Google, easyJet, Unilever, Procter & Gamble, Novartis, and Lafarge Holcim – have sought to buy carbon offsets or carbon removals to become net zero within the next decade. Microsoft buys only carbon removals from the atmosphere. It is focusing on forestry, soil, and biochar projects or direct air capture technologies (1.3 million tCO_2e in 2020), while being open to other removal opportunities and technologies in the future. In the near term, Microsoft is targeting an average price of $15 per tCO_2e with a view to being affordable at scale (for example, $100/tCO_2e$ in five to 10 years).[65]

Another example is reinsurer Swiss Re, which is compensating for its carbon emissions with carbon removal certificates. It applies an internal carbon price, which started at $100 in 2021 and will increase to $200 by 2030.[66] Such price trends provide a positive outlook for mangrove and seagrass restoration finance through the sale of blue carbon credits.

It is expected that the prices of blue carbon offsets will increase relatively steeply during the first half of this decade (see Figure 11). Price is driven mainly by the overwhelming demand from corporates to fulfill their net-zero targets and support their carbon neutrality claims, and the lack of supply to fulfill the demand. The pace of this supply/demand imbalance, and consequent price increase, is expected to slow in the second half of the 2020s. After 2030, the price of blue carbon offsets is expected to plateau, as more supply enters the market, while the level of uncertainty rises over time. The increasing uncertainty has been captured by the price corridor (gray area in the chart), while the blue line shows our estimates for the price development.

FIGURE 11: PRICING CORRIDOR FOR BLUE CARBON VOLUNTARY EMISSION REDUCTIONS UNTIL 2030 (IN NOMINAL $ PER TON)



3.2 Monetizing co-benefits

There is a significant disconnect between the value of the ecosystem services that coastal ecosystem restoration projects can deliver and the premium on top of a carbon credit price that these projects are able to secure. The value of the ecosystem services of these projects is well documented (see Box 1 for more detail). Carbon pricing, on the other hand, is notoriously untransparent and evidence of premiums paid for co-benefits is difficult to quantify.

It is important to distinguish between prices paid to the project developer and the prices paid when the project's carbon credits are commoditized and sold on. In today's carbon markets, the price a project developer is able to secure is often determined in a forward contract that is agreed between the project developer and the primary buyer at an early stage of the project's development. In addition to the market price at that moment, the price agreed will depend on a number of factors, including:

- **Project type**: Blue carbon projects tend to secure higher prices than other land-use projects, which in turn tend to secure higher prices than energy and waste projects.
- **Applied standard**: Projects applying carbon standards that are perceived to be of higher quality (VCS, Gold Standard) tend to secure higher prices.
- **Geographical location**: Emission reductions from countries with few projects appear attractive to certain buyers, giving buyers a sense of uniqueness. This could also apply to projects in least developed countries, although such projects may come at a discount due to country risk.
- **Volume offered**: Volumes from small projects can trade at a premium; large transaction volumes from big projects may qualify for discounts. It is too early and the market is too illiquid to take any pricing lessons from the few existing blue carbon projects. One of the first projects, Mikoko (a small project), sold its credits in recent years for between $4 and $12. That was before the increased interest in blue carbon projects that we see today. Drawing an analogy with other NBS sectors: if blue carbon price signals follow pricing approaches from other forestry credits, volumes from smaller projects can trade at a premium (100 percent or more).

- **Risk distribution** between the project developer and buyer and the risk perception of the buyer.
- **Additional amenities** the buyer can make available, for instance, pre-payments to fund project development and receive credits at a discount in return for taking project development risk.
- **The length of the delivery obligation**: Longer commitments from the buyer will come at discounted prices.
- **Co-benefits**: Projects featuring concrete co-benefits may be able to secure a premium.[67]

To secure a premium, a co-benefit first needs to be described, monitored, and usually certified. Co-benefits that are of interest to investors include gender equality, economic growth, job creation, access to clean energy, and biodiversity. As most blue carbon projects are developed under the VCS standard, co-benefits can be certified through Verra's Climate, Community and Biodiversity Standards. Plan Vivo has certification of co-benefits integrated in its program.

Some estimates suggest that carbon-credit-issuing projects with a likelihood of delivering the highest co-benefits are priced 30 percent higher than projects with the lowest co-benefits.[68] Project quality indicators such as the Gold Standard (not for blue carbon), by conveying a higher likelihood of local co-benefits, suggest a significant price premium in the range of 6.6 percent to 29 percent.[69]

The private sector Taskforce on Scaling Voluntary Carbon Markets has collectively arrived at a solution for which co-benefits should count as part of a carbon credit. The Taskforce explicitly includes co-benefits as "additional attributes" to classify carbon credits. Businesses can gain recognition for many of the beneficial "side effects" of the carbon projects they support, which include many of the Sustainable Development Goals.[70]

Mikoko Pamoja was one of the first mangrove restoration and reforestation projects, spanning 117 ha of nationally owned mangroves in the Gazi Bay of Kenya. This community-based project is financed by the revenues from Plan Vivo-issued carbon credits in the VCM and benefits 5,400 members of the local community. The price of these credits ranges between $4 and $12. The credits channeled $36,000 into the community from 2013 to 2017, of which 30 percent was earmarked for investment in education and clean water supply.[71] The project has faced various challenges, including demand for credits, low issued volumes that prevented economies of scale, and changing climate patterns that led to seedlings dying. Nonetheless, it has been successful due to the active participation of the community and scientific research in this area.[72]

The Blue Carbon Project Gulf of Morrosquillo in Colombia, which began in 2015, aims to achieve adequate management of mangroves, promote sustainable development, strengthen local governance, and promote alternative productive activities. It is contributing to the protection of the manatee and needle caiman. The project has been verified under Verra's Climate, Community and Biodiversity certification and has received considerable public exposure thanks to the involvement of Apple and Conservation International. This exposure has also contributed to the higher prices of the project's credits, which fetch as much as $8 to $29 in the voluntary carbon markets.[73]

Considerable non-carbon benefits are attributed to these two projects, such as socioeconomic contributions and environmental services, yet their credits have attracted different prices. This is in part due to their credits coming into the market at different times and the fact that the Gulf of Morrosquillo project has an additional certification under Climate, Community and Biodiversity, which adds costs but ensures further verified benefits.

BOX 1: VALUE OF ECOSYSTEM SERVICES OF BLUE CARBON PROJECTS[a, b, c]

Coastal wetlands benefit many coastal communities by protecting them from flooding, storm surges, and storm events; preventing loss of life, housing, infrastructure, and food sources; and preventing saltwater intrusion.[a] This is particularly important as vulnerable communities are often critically dependent on these contributions. When mangroves, saltmarshes, and seagrasses are damaged or destroyed, the absence of these natural barriers has been shown to increase the damage to coastal communities from standard wave action and violent storms. Furthermore, tidal wetlands can help realize a blue economy for local communities by attracting comprehensive investments, such as in the conservation of tidal wetlands and biodiversity, and in blue infrastructure projects.[b] Studies have estimated that tidal wetlands offer $193,945 per ha per year in terms of ecosystem services.[c]

Saltmarshes are widely recognized as providing valuable ecosystem services for surrounding communities. They cover less than 1 percent of the earth's surface, yet are estimated to account for 20 percent of the global value of ecosystem services.[d]

Seagrasses also provide important ecosystem services that have been valued in millions of dollars. For example, in Thailand the benefits they offer are valued at $275 million.[e]

Studies have assessed the value of mangroves, yet they vary depending on the number of services considered. In the coastal areas of India, their ecosystem services are valued at between $177/ha and $232/ha,[f] while in Thailand the estimates of their value are higher at between $10,158/ha and $12,392/ha.[g] In the Gulf of California, fisheries landings are positively related to the local abundance of mangroves: the annual economic median value of these fisheries is $37,500/ha of mangrove.[h] In Southeast Asia, studies have demonstrated that the annual value of foregone mangrove ecosystem services would be $1.7 billion to Indonesia and $279 million to Malaysia.[i]

a. Brander, L. M., A. J. Wagtendonk, S. S. Hussain, A. McVittie, P. H. Verburg, R. S. de Groot, and S. van der Ploeg. 2012. "Ecosystem Service Values for Mangroves in Southeast Asia: A Meta-Analysis and Value Transfer Application." *Ecosystem Services* 1 (1): 62.

b. Thiele, T., et al. 2020. "Blue Infrastructure Finance: A New Approach, Integrating Nature-Based Solutions for Coastal Resilience." UCN, Gland, Switzerland. https://bluenaturalcapital.org/wp2018/wp-content/uploads/2020/03/Blue-Infrastructure-Finance.pdf.

c. De Groot, et al. 2012. "Global Estimates of the Value of Ecosystems and Their Services in Monetary Units." A look at ecosystem services such as food, water, raw materials, genetic resources, medicinal resources, ornamental resources, air quality regulation, climate regulation, disturbance moderation, regulation of water flows, waste treatment, erosion prevention, nutrient cycling, pollination, biological control, nursey services, genetic diversity, esthetic information, recreation, inspiration, spiritual experience, and cognitive development.

d. Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber, and R. K. Turner. 2014. "Changes in the Global Value of Ecosystem Services." *Global Environmental Change* 26: 152–58.

e. Praisankul, S., and O. Nabangchang-Srisawalak. 2016. "The Economic Value of Seagrass Ecosystem in Trang Province, Thailand." *Journal of Fisheries and Environment* 40 (3): 138–55.

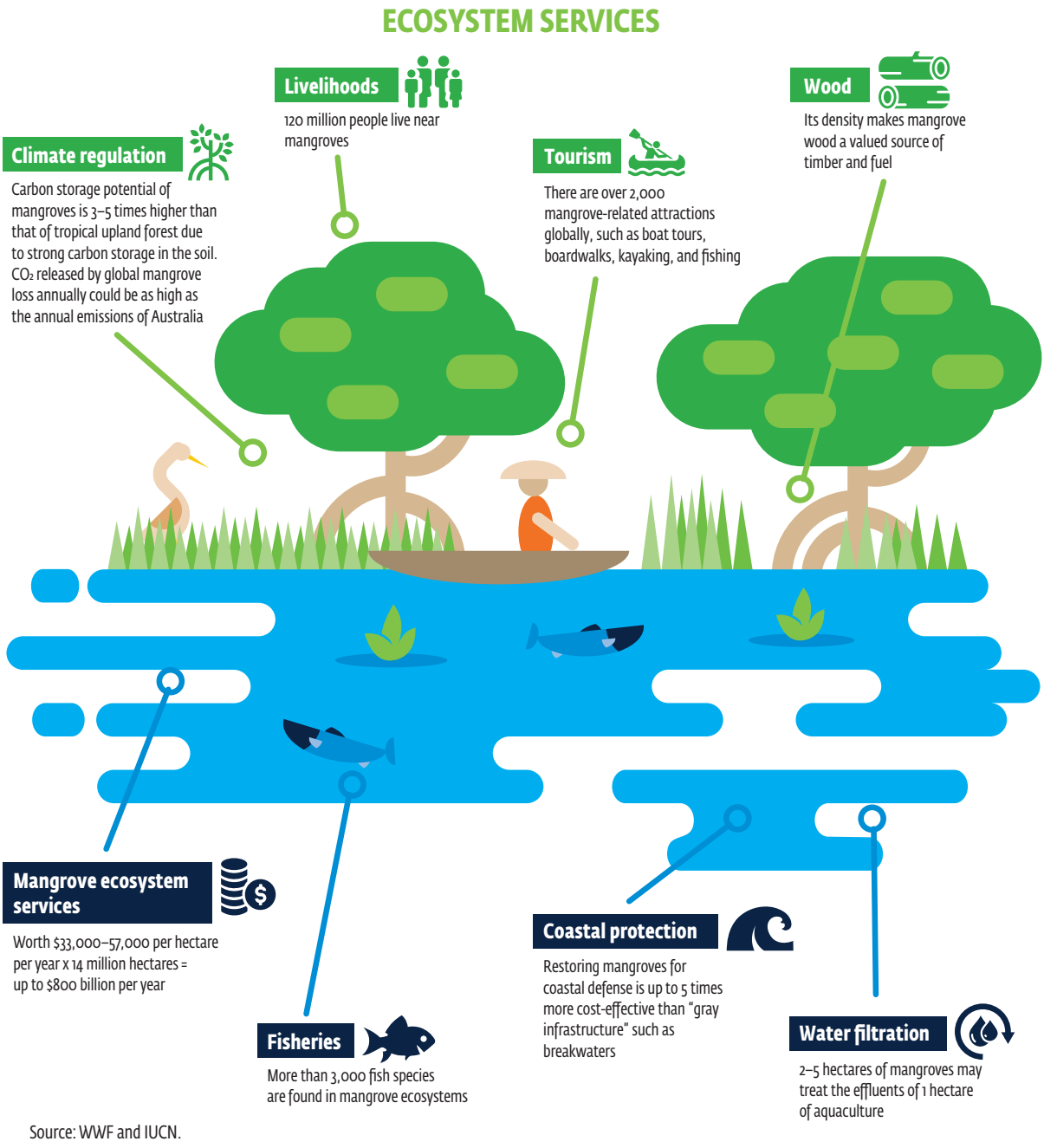
f. Das, S., and A. S. Crépin. 2013. "Mangroves Can Provide Protection against Wind Damage During Storms." *Estuarine, Coastal and Shelf Science* 134: 98–107.

g. Barbier, E. B. 2007. "Valuing Ecosystem Services as Productive Inputs." *Economic Policy* 22 (49): 178–229.

h. Aburto-Oropeza, O., E. Ezcurra, G. Danemann, V. Valdez, J. Murray, E. Sala, et al. 2008. "Mangroves in the Gulf of California Increase Fishery Yields." *Proceedings of the National Academy of Science of the USA* 105 (30): 10456 – 9.

i. Brander, L. M., A. J. Wagtendonk, S. S. Hussain, A. McVittie, P. H. Verburg, R. S. de Groot, and S. van der Ploeg. 2012. "Ecosystem Service Values for Mangroves in Southeast Asia: A Meta-Analysis and Value Transfer Application." *Ecosystem Services* 1 (1): 62–9.

FIGURE 12: SERVICES OF COASTAL ECOSYSTEMS



Source: WWF and IUCN.

4.

Financing Blue Carbon Projects

4.1 Funding gaps and barriers

Mobilizing capital investments for conservation remains one of the primary obstacles to managing and restoring coastal blue carbon ecosystems. Some estimates suggest that $15 billion for mangrove restoration is needed between 2021 and 2050 alone,[74] and much more funding is required to restore seagrasses and tidal marshes.

There is growing understanding of the variety of obstacles and barriers to financial scaling in general, and of the roadblocks for private sector financing of NBS in particular.[75] Regulatory and governance issues are among the most persistent and systemic barriers.[76] The rules according to which NBS, including coastal NBS, can be implemented and financed is often incomplete. There is also the practice of creating or maintaining detrimental regulatory regimes – that is, those that incentivize or compel policies and actions to negate or go against NBS.

It is often pointed out that there is a lack of appropriate risk-return profiles, especially for untested NBS projects.[77] There are also specific barriers linked to carbon project development, namely:

- **High risk profile of blue carbon projects**: Like other types of investments, the bankability of a blue carbon project depends on factors such as the predictability of its cash flow and its associated risk profile, which inform investors of potential returns on investment and expected yields. Banks and investors lack the strategy and capabilities to commit to a relatively marginal asset class in which ticket sizes tend to be small compared with the effort required. Additionally, business models that rely on carbon credits must allocate funds for validation, monitoring, and verification processes before issuing carbon credits, contributing to the upfront costs and the time lag between initial investments and returns from selling carbon credits. For example, a mangrove restoration project's success might depend on the survival rate of the mangrove seedlings, which can be challenging to predict. Thus, the cost of conserving and restoring tidal wetlands can be higher than the potential income generated from carbon credits. Governments could fill this role by providing first-loss guarantees, floor prices, or other support mechanisms to incentivize investors. Financial institutions could find ways to layer blue carbon into portfolio allocation frameworks.
- **Small project scale and long time frames**: For blue carbon ecosystems, it is difficult to reach a cost-effective scale for conservation or restoration projects. An additional uncertainty related to risk-return profiles is the long-term propositions to scale – especially for seagrass. For the world's largest seagrass restoration project in Virginia, researchers and volunteers took the best part of two decades to spread more than 70 million seeds to restore 3,600 ha of a devastated ecosystem.[78] It has been noted that access to larger-scale opportunities is the main factor that would encourage asset owners and managers to increase their exposure to natural capital investments.[79] This barrier could be overcome by aggregating several projects and pooling services and expenses, to lower costs and increase the overall ticket size of the investments.

- **Climate change impacts**: Studies suggest that tidal wetlands are particularly vulnerable to the effects of climate change, with potentially higher degradation rates than terrestrial ecosystems.[80] The permanence of blue carbon projects can be threatened by multiple climate change stressors such as sea level rise and warming that could affect the viability of seagrass restoration and can account for long-term uncertainty.
- **Institutional complexities and lack of capacity**: Blue carbon is a relatively novel mitigation activity in carbon markets. As a result, many countries and national agencies do not have sufficient experience, technical expertise, and financial literacy to develop carbon projects in tidal wetlands. Low-income and lower-middle-income countries may lack the technical capacity to integrate blue carbon ecosystems into their adaptation and mitigation planning and develop project pipelines. Moreover, the slow translation of international policies to national and subnational levels could hinder domestic plans and applicable regulations, and tidal wetlands are usually not mainstreamed in the design of public infrastructure projects. In some countries, limited coordination between ministries and government agencies hampers uptake, as government agencies dealing with infrastructure projects and those managing natural capital work in silos and lack collaborative approaches.[81]
- **Land tenure and engaging with coastal communities**: Nearer to shore, land tenure issues abound and remain a key driver of land degradation and a bottleneck for investment in sustainable land management forms. Moreover, lack of ownership leads to an unclear delineation of carbon rights within the tidal zone, which can pose additional challenges. Coastal blue carbon project developers must closely engage indigenous people and small-scale food-producing communities and respect their access and tenure rights. In many cases, empowering traditional and community stewardship of marine resources may be sufficient to achieve coastal protection and natural regeneration. The conservation of tidal wetlands involves many stakeholders and requires multifaceted community-led development projects to address underlying drivers of destruction and unsustainable use.[82]

Carbon markets can help tackle these barriers, steer conservation and restoration action, and stem some of these costs. However, it is unlikely that they can deliver on all the needs – in terms of restoration as well as costs – without other financing mechanisms and financial structures.

It is promising, therefore, that in recent years a range of new financing sources and structures have emerged that can help bridge the financing gap and tackle specific challenges around blue carbon project development, especially if combined with blended finance products.

4.2 Project opportunities

The different roadblocks for blue carbon project development will not disappear overnight. Some of these obstacles – particularly land tenure uncertainties, which are common – are the result of structural problems, which may require transformational policy, laws, and societal interventions to solve, and these solutions are unlikely to happen in the near future.

Sizing up

However, the existing blue carbon project portfolio offers practical lessons for scaling blue carbon activities and replicating projects across the globe. The first lesson relates to sizing up – that is, securing an area of land available for restoration that is large enough to cover the high transaction costs identified above. Coastal areas are often under immense land-use pressure. Degradation happened for a reason, and often degraded areas are used for roads, ports, houses, agriculture, and other kinds of infrastructure. That often means restoration capacity is limited to a few hectares here or there – insufficient to attract a carbon project.

The (Indus) Delta Blue Carbon project in Pakistan shows how to reach scale. It projects restoration of 350,000 ha by, among other ways, helping farmers switch from extensive to intensive cattle farming (rotational grazing) and disseminating the practice across the Indus Delta. The project may be exceptional in size, but similar projects could be developed in tandem with transforming agricultural and aquaculture practices. For example, shrimp farming – a major driver of deforestation of mangroves – can be rendered much more effective in many countries and settings by intensifying area use and reintroducing mangroves.

Governance and public-private partnerships

A second lesson relates to governance and the creation of public-private partnerships. Government agencies will usually play a major role in mangrove governance. They often own the land, regulate fisheries and aquaculture, and are responsible for coastal management. This can create problems of its own, but it can also create opportunities. The Delta Blue Carbon project was able to access its large intervention area because the state government (Sindh Province) is behind the project and offers its services through its Forest and Wildlife Department.

Local and state governments engaging with government agencies are often (necessary) key partners for blue carbon projects, certainly in all federalized or devolved jurisdictional systems. Increasingly, however, carbon project development also requires facilitative action from the central government. It is central governments that control international climate cooperation and NDC design. Voluntary carbon markets may not need explicit backing in NDCs, but project developers must increasingly prove that a project aligns with a country's NDC policy and does not create "hot air" at NDC accounting level.

Blue carbon initiatives in host countries that embrace the use of carbon markets, have a proven track record in developing carbon projects (blue carbon and forest carbon specifically), and indicate in their NDC the use of (voluntary) carbon markets to achieve specific targets, will be at an advantage. It is too early to say whether the practice will materialize at scale of using state-sponsored authorization instruments under Article 6 of the Paris Agreement for voluntary purposes, as is sometimes argued[83] (with the consequence of employing so-called "corresponding adjustments" for voluntary projects in country NDCs). By contrast, several developing countries have recently moved to severely restrict unauthorized voluntary carbon project development (for example, Madagascar) or to suspend credit issuance from voluntary projects altogether (for example, Indonesia). These examples point to regulatory risks that project developers and investors must be increasingly aware of. This risk turns into an opportunity for host countries that provide clear guidance on their policy support for voluntary carbon markets.

Community engagement

A third lesson relates to community engagement. Blue carbon projects will usually affect, and be affected by, coastal communities. It is paramount to include local communities in project design and implementation. Thus, any blue carbon project developer should frontload community outreach activities and have experienced community outreach experts in their team when formulating a project theory of change and benefit-sharing mechanism.

4.3 Financial structures and flows

Finance – and the availability of advance funding to develop and implement projects – has long been a major roadblock for blue carbon projects, and it remains so where specific interventions are more expensive (per tCO_2e) than what carbon markets offer.

However, it is important to realize that the broader opportunities presented by a transition to a sustainable blue economy[84] provide for multiple investment and financing streams that can complement blue carbon finance in the mid to long term.

The various financing sources can be structured into different types, namely:

- **Stand-alone blue carbon finance**: Stand-alone blue carbon assets can be built as described above, using voluntary carbon markets. They may also come in the form of non-market, results-based finance approaches (often practiced for REDD+). In this approach, funding is provided by governments or dedicated national or multilateral funds (such as the Carbon Fund of the Forest Carbon Partnership Facility) and/or via concessional loans, guarantees, or grants from multilateral, regional, bilateral, or national development banks. In these cases funding is limited to what carbon markets pay per tCO_2e. While demand is currently strong, many project developers are in need of long-term price predictability and long-term offtake agreements to go ahead with their projects or expand them.

POTENTIAL SCOPE OF FINANCIAL INSTITUTIONS' INVOLVEMENT

Provide capacity building and funding to financial institutions as intermediaries that will on-lend to blue carbon finance developers, especially small and medium enterprises.

Offer long-term offtake agreements (10 or 15 years) to blue carbon developers at fixed prices and provide access to advance funding.

Create blended finance support for blue carbon finance interventions that are either too expensive to be funded from carbon markets (prices of $50 per ton or more) or that are still in the proof-of-concept phase, including many seagrass conservation/ restoration projects.

- **"Nested" blue carbon considerations in value chains:**
  - **Blue infrastructure**: Integrating nature into mainstream infrastructure systems can lower the carbon footprint and overall costs, while increasing the climate resilience of the systems concerned.[85] Blue infrastructure aims to replace traditional "gray" infrastructure (such as dams, levees, and reservoirs) with "blue" elements – such as mangrove forests or floodplains – or combine both to enhance the overall effect of the infrastructure as well as the habitats concerned. To our knowledge, there are no nested projects of this sort yet. The sponge city concept follows a blue infrastructure approach. Instead of using concrete to seal off a city from incoming water, coastal or freshwater wetlands are restored to absorb, clean, and use the water.
  - **Economic sector activities**: Various sectors impact and/or rely on coastal habitats. Examples include agriculture, aquaculture, and tourism. While the carbon footprint cannot be made to disappear, it can be substantially reduced through the use of NBS. In turn, the use of NBS can make the investment more resilient and augment the underlying asset. Global ecotourism destinations such as Costa Rica are evidence of the economic concept.

POTENTIAL SCOPE OF FINANCIAL INSTITUTIONS' INVOLVEMENT

Design and pilot financial products that target investments in coastal blue infrastructure and coastal blue supply chains (for example, sustainable aquaculture (with clear safeguards) and ecotourism).

Build awareness and capacity, and provide financial incentives to integrate nature-based solutions/ blue infrastructure into larger infrastructure projects to perform a core technical function and displace or complement manmade structures.

- **Blue finance**: The financial sector is increasingly interested in separating blue finance from traditional finance, and there is ever more guidance on what can be considered a sustainable blue investment and what cannot. The EU sustainable finance taxonomy, the Green Bond Principles, the Green Loan Principles, and IFC's Guidelines for Blue Finance identify which types of investments can be deemed green or blue, and at what scale. This guidance is supported by transparency provisions on risks posed by environmental degradation, such as those identified by the Task Force on Climate-related Financial Disclosures. While the guidance is not flawless, it provides clear incentives for private and public investors to orient their investment portfolio towards green and blue opportunities.

POTENTIAL SCOPE OF FINANCIAL INSTITUTIONS' INVOLVEMENT

Revisit guidelines for blue finance to add red (No-Go) and green (Go) lists for the blue finance areas, ensuring that no new deforestation or degradation of coastal wetlands happens and clarifying that coastal wetland ecosystem interventions have generally high (three-star) impacts for mitigation and adaptation.

- **Insurance and resilience**: Where investments in coastal wetlands help reduce property damage, the insurance market is – or will over time – be interested. Studies produced in the aftermath of Hurricane Sandy in the Atlantic Ocean in 2012 found that damage was reduced by 20 percent to 30 percent in areas protected by natural wetlands compared to those that were unprotected.[86] This suggests that insurance providers that offer policies on flood risks should look at this data to decide where (and at what price) they can sell policies and where they will not. However, the industry still lacks the tools to adequately calculate resilience and other benefits from mangroves and other blue carbon habitats.[87] Verra's current efforts to develop a methodology for measuring coastal resilience benefits from restoration and protection of tidal wetlands may help move the matter forward.[88]

POTENTIAL SCOPE OF FINANCIAL INSTITUTIONS' INVOLVEMENT

Support insurers in developing markets (through financial assistance and advisory services) to tailor flood risk policies to wetland enhancement interventions.

- **Debt instruments (including bonds)**: Corporations and governments increasingly use green – and more recently also blue[89] – bonds that are focused on nature conservation, restoration, and sustainable use, especially in jurisdictions that are known for their natural capital and ecosystems (for example, the Seychelles, for which the first blue bond, orchestrated by the World Bank, was issued in 2018).

  A significant increase in green bond issuance for biodiversity and sustainable land use could take place under specific conditions, such as more clarity on proven business models, risk mitigation instruments, and impact-reporting metrics. Blue activities could be nested within a multisectoral green bond to realize the landscape approach and reach the scale demanded by bond issuers and investors.

POTENTIAL SCOPE OF FINANCIAL INSTITUTIONS' INVOLVEMENT

Building on experience with issuing green bonds, design "blue" bond products to focus on coastal wetland conservation and restoration activities and define workable metrics and impact frameworks to evaluate the use of relevant proceeds.

Revise definitions and metrics for climate-related activities to define direct and nested coastal wetland conservation and restoration activities.

The various financing types can also be combined, and financial involvement would add a blended finance structure (see Box 2). There are immense opportunities for multilateral development banks to integrate coastal conservation and restoration into their operations.[90]

BOX 2: BLENDED FINANCE

When traditional finance is insufficient to attract investments for nascent projects, blended finance can come into play. Blended finance is a model that allows different types of capital to invest alongside each other, such as grants and concessional finance (for example, low-interest loans and price guarantees). These funds come from governments, multilateral development banks, or philanthropic elements within civil society, such as not-for-profit organizations or high-net-worth individuals, and are used in a way that removes uncertainty or risk.

In a recent publication, Earth Security noted that over 31 vehicles are used to finance sustainable forest management, agroforestry and agriculture, and the sustainable management of coastal wetland and marine ecosystems.[a] They represent just 5 percent of the overall suite of blended finance transactions, with a combined fundraising target of just over $5.1 billion. This reflects the nascent stage of commercial investments that focus on nature protection since blended finance requires NBS projects to have a commercial element and deliver a cash flow that can remunerate private investors. The Blended Finance Task Force's investor roundtable agreed that blue carbon could be a crucial pathway for increasing private investment in coastal and marine conservation projects, as it provides a standardized and measurable tool. To make these investments attractive, blue carbon revenue streams could be combined with projects such as sustainable fisheries, ecotourism, and coastal infrastructure.

a. Earth Security. 2021. "The Blended Finance Playbook for Nature-Based Solutions." https://www.convergence.finance/resource/the-blended-finance-playbook-for-nature-based-solutions/view.

5.

Blue Carbon Opportunities for FIs

5. Blue carbon opportunities for FIs

Blue carbon projects are enjoying increasing popularity in carbon markets, not least because they neatly bridge what are often described as alternatives: climate change mitigation and adaptation.

Blue carbon projects are coming into the market late because these projects are complex and are constrained by multiple serious barriers. The drivers behind coastal ecosystem degradation are strong and persistent. Coastal zones are among the most densely populated parts of the planet and degradation of ecosystems in these areas is often caused by infrastructure development (roads, ports, cities), economic activity (fisheries, forestry), and sprawling urbanization (pollution, construction).

The income from carbon finance can lower the financial barriers to tidal ecosystem restoration but often leaves many of the other barriers unresolved. The scale of projects is a major restriction, with only a few opportunities identified so far that have a restoration size larger than 10,000 ha. The vast majority have a project size well below financial institutions' investment thresholds. Of the 23 projects currently known to carbon standards, only three are projected to generate more than 1 million tCO_2e of carbon credits per year.

Two other factors limit investment opportunities for financial institutions in this sector. First, governmental organizations are often the central entity in blue carbon projects. The contracting party for the carbon credit transaction would likely be a private entity while a governmental organization could be local or regional. Second, blue carbon projects are in high demand and consequently a fair number of large buyers are willing to commit to forward carbon credit agreements and offer amenities, including premium prices and even upfront payments. Nonetheless, there are a number of opportunities in the nascent blue carbon market in which financial institutions can play a pivotal role, as noted in section 4.3.

Opportunities in carbon transactions

First, there will be opportunities to offer firm carbon purchase agreements to developers of blue carbon projects, in particular when the requested price for carbon credits is above the current appetite of major buyers or when the proposed intervention is still in the proof-of-concept phase. By acting as a primary buyer, offering premium prices, and providing partial upfront finance, financial institutions can enable the development of highly visible yet costly tidal ecosystem restoration initiatives. These transactions can be particularly risky. Financial institutions would assume a share of the project development and counterparty risk, as well as the carbon market price risks. A comparable additional role would arise when a financial institution assumes a part of the project development and operating risk by forward purchasing carbon credits second in line, in support of a carbon credit buyer that would commit to taking off, for example, the more secure first 50 percent of generated carbon credits.

Second, financial institutions can promote the implementation of NBS in coastal infrastructure projects in which they are participating as a financier. These include development projects for ports, other coastal infrastructure, and tourism. As the scale of the blue carbon parts of these investments would likely be limited, financial institutions can propose and coordinate bundling these interventions into carbon programs.

Other opportunities in tidal ecosystem restoration

There are also opportunities for financial institutions to support the development of the blue carbon market, as elaborated in section 4.3:

- Revising existing guidelines for blue finance to add red (No-Go) and green (Go) lists for the blue finance areas, ensuring that no new deforestation or degradation of coastal wetlands happens and clarifying that coastal wetland ecosystem interventions have generally high (three-star) impacts for mitigation and adaptation.
- Supporting insurers in developing markets (through financial assistance and advisory services) to tailor flood risk policies to wetland enhancement interventions.
- Building on experience with issuing green bonds, designing "blue" bond products to focus on coastal wetland conservation and restoration activities, and defining workable metrics and impact frameworks to evaluate the use of relevant proceeds.
- Revising definitions and metrics for climate-related activities to define direct and nested coastal wetland conservation and restoration activities.

6.

Annex – Overviews

6.1 Overview of projects

TABLE 1: OVERVIEW OF BLUE CARBON PROJECTS

NAME	STANDARD AND METHODOLOGY	STATUS	REGION	SIZE (HA)	ANNUAL EMISSION REDUCTIONS/ REMOVALS (IN TCO_2E)
Restoring Wetlands on California Department of Water Resources-Owned Areas of Twitchell and Sherman Islands	ACR – The Restoration of California Deltaic and Coastal Wetlands methodology, version 1.0 adopted in April 2017 by the American Carbon Registry (ACR)	Registered	Northern America	3,440	59,552
Virginia Coast Reserve Seagrass Restoration Project	VM0033	Under development	Northern America	66,452	1,349
Zhanjiang Mangrove Afforestation Project	VCS – AR-AM0014/ Version 03.0	Registered	Eastern Asia	380	4,020 (6,534 verified in 2021)
Reforestation and Restoration of Degraded Mangrove Lands, Sustainable Livelihood, and Community Development in Myanmar	VCS – AR-AM0014	Registered	Southeastern Asia	2,100	184,006 (59,299 issued in 2020)
Mangrove Restoration and Sustainable Development in Myanmar	VCS – AR-AM0014	Under development	Southeastern Asia	2,100 (4,500 in PD)	403,831
Delta Blue Carbon 1	VM0033	Registered	Southern Asia	350,000 (224,997 in PD)	2,407,629
Livelihoods' Mangrove Restoration Grouped Project in Senegal	VCS – AR-AM0014	Registered	Sub-Saharan Africa	10,415	30,000 (228,542 issued in 2021)
Blue Forest & Mozambique: Building Africa's Largest Mangrove Restoration Project	VM0007	Under development	Africa	183,000	2,965,555
Senegal and West Africa Mangrove Programme	VM0007	Under development	Africa	42	2,547
The Haidar el Ali Mangrove Initiative (HEAMI)	AR-AMS0003	Under development	Africa	2,000	30,170
Mangrove Restoration and Coastal Greenbelt Protection in the East Coast of Aceh and North Sumatra Province, Indonesia	VCS – AR-AM0014	Registered	Southeastern Asia	1,000	124,706 (125,391 issued in 2019)
OKI REDD+ Project	AR-AM0014, VM0007, AR-ACM0003	Registered	Southeastern Asia	23,500	181,986

NAME	STANDARD AND METHODOLOGY	STATUS	REGION	SIZE (HA)	ANNUAL EMISSION REDUCTIONS/ REMOVALS (IN TCO_2E)
India Sundarbans Mangrove Restoration	VCS – AR-AM0014	Registered	Southern Asia	4,675	51,249 (119,139 issued in 2018)
Mangrove Restoration Project with Sine Saloum and Casamance Communities, Senegal	VCS – AR-AM0014	Under validation	Africa	7,020	95,470
Hainan Lingshui Mangrove Blue Carbon Project	VCS – AR-AM0014	Registration requested	China	192	75,796
Carbon Sequestration in Mangroves of the South-Central Coastal Zone of the State of Sinaloa	VM0007	Under development	Latin America	49,387	3,123,836
Blue Carbon Project Gulf of Morrosquillo "Vida Manglar"	VM0007	Registered	Latin America	7,561	31,310
Protection of Mangroves and Community Developmental Activities in the Biodiversity Hotspot of Colombia	VM0015	Under development	Latin America	64,000	460,000
Bonos del Jaguar Azul	VM0033	Under development	Latin America	5,060	48,518

NAME	STANDARD AND METHODOLOGY	STATUS	REGION	SIZE (HA)	ANNUAL EMISSION REDUCTIONS/ REMOVALS (IN TCO_2E)
Restoring Mangroves in Mexico's Blue 2500 – Carbon Ecosystems	VM0033	Under development	Latin America	32,914	868,302
Mikoko Pamoja	Plan Vivo (project-specific calculation)	Registered	Africa	125	9,880 (by 2021)
Tahiry Honko	Plan Vivo (project-specific calculation)	Registered	Africa	1,400	1,375 (none yet issued)
Vanga Blue Forest	Plan Vivo (project-specific calculation)	Registered	Africa	460	5,000 (none yet issued)

6.2 Overview of project developers

TABLE 2: OVERVIEW OF PROJECT DEVELOPERS

DEVELOPER	BRIEF DESCRIPTION	WEBSITE	BLUE CARBON PROJECTS	COUNTRIES
OCEANIUM	OCEANIUM is a Senegalese NGO focused on environmental conservation. Since 2007, OCEANIUM has developed pilot reforestation projects in wetlands.	Not available	Livelihoods' Mangrove Restoration Grouped Project in Senegal	Senegal
			The Haidar el Ali Mangrove Initiative (HEAMI)	Senegal
			Mangrove Restoration Project with Sine Saloum and Casamance Communities, Senegal	Senegal
YAGASU	YAGASU is an Indonesian NGO that provides finance for environmental and community development programs in forest conservation, ecosystems restoration, climate change mitigation, and sustainable eco-friendly business.	Link	Mangrove Restoration and Coastal Greenbelt Protection in the East Coast of Aceh and North Sumatra Province, Indonesia	Indonesia
The Nature Environment & Wildlife Society (NEWS)	NEWS is an Indian NGO focused on three areas: ecology and environment, wildlife conservation, and livelihood augmentation.	Link	India Sundarbans Mangrove Restoration	India
Prime Carbon Co Ltd	Prime Carbon develops forest carbon/REDD+ project activities in Southeastern Asia.	Not available	Reforestation and Restoration of Degraded Mangrove Lands, Sustainable Livelihood, and Community Development in Myanmar	Myanmar
Third Institute of Oceanography (TIO)	TIO is a non-profit research institute focused on marine economy development. TIO belongs to China's Ministry of Natural Resources.	Link	Zhanjiang Mangrove Afforestation Project	China

DEVELOPER	BRIEF DESCRIPTION	WEBSITE	BLUE CARBON PROJECTS	COUNTRIES
Climate Impact Partners	Climate Impact Partners is an international advisory company focused on carbon emissions reduction.	Link	Zhanjiang Mangrove Afforestation Project	China
The Nature Conservancy Virginia Chapter	TNC is a worldwide environmental organization that develops land-use and water conservation projects.	Link	Virginia Coast Reserve Seagrass Restoration Project	United States
California Department of Water Resources (DWR)	DWR manages water resources and plans climate change mitigation projects in California.	Link	Restoring Wetlands on California Department of Water Resources-Owned Areas of Twitchell and Sherman Islands	United States
ECOACT	ECOACT is an international climate change mitigation project developer that also designs decarbonization strategies.	Link	Mangrove Restoration and Sustainable Development in Myanmar	Myanmar
Delta Capital Limited	Delta Capital is an international blue carbon developer that works in partnership with the government of Sindh.	Link	Delta Blue Carbon 1	Pakistan
Blue Forest	Blue Forest is an international advisory company that focuses on environmental project development and financing.	Link	Blue Forest & Mozambique: Building Africa's Largest Mangrove Restoration Project	Mozambique
ALLCOT	ALLCOT focuses on measuring and developing greenhouse gas emissions reduction strategies.	Link	Senegal and West Africa Mangrove Programme Carbon Sequestration in Mangroves of the South-Central Coastal Zone of the State of Sinaloa	Senegal Mexico
YL Forest Co	YL Forest is a Japanese corporation focused on reforestation and forest protection projects, including planting mangroves and REDD+ activities.	Link	OKI REDD+ Project	Indonesia
China Green Carbon Foundation (CGCF)	CGCF is a non-profit public funding foundation that supports and develops climate change mitigation projects, especially in China.	Link	China Green Carbon Foundation	China
Conservation International Foundation (CIF)	CIF is an American environmental organization that develops projects in America, Africa, and Asia Pacific.	Link	China Green Carbon Foundation Blue Carbon Project Gulf of Morrosquillo "Vida Manglar"	China Colombia

DEVELOPER	BRIEF DESCRIPTION	WEBSITE	BLUE CARBON PROJECTS	COUNTRIES
WeAct Pty Ltd	WeAct is an Australian carbon project developer focused, among others, on certified emission reductions and voluntary carbon offsets.	Link	Protection of Mangroves and Community Developmental Activities in the Biodiversity Hotspot of Colombia	Colombia
The Earth Lab	The Earth Lab is a Mexican environmental project designer and developer focused on climate change mitigation.	Link	Bonos del Jaguar Azul	Mexico
BlueMX Mangrove A.C.	BlueMX is a Mexican company created to manage and develop blue carbon projects in Mexico. Currently, BlueMX manages projects that impact more than 100 ha of mangroves.	Link	Restoring Mangroves in Mexico's Blue 2500 – Carbon Ecosystems	Mexico

DEVELOPER	BRIEF DESCRIPTION	WEBSITE	BLUE CARBON PROJECTS	COUNTRIES
Association for Coastal Ecosystem Services (ACES)	ACES supports and develops mangrove conservation projects under a "payment for ecosystems services" model.	Link	Mikoko Pamoja Vanga Blue Forest	Kenya Kenya
Worldview International Foundation (WIF)	WIF is a worldwide non-profit foundation focused on mitigating climate change in developing countries.	Link	Thor Heyerdahl Climate Park in the Delta Region of Myanmar	Myanmar
Solon Capital Partners	This company manages West-Africa-focused investments to increase people's living standards in post-conflict regions.	Link	West Africa Blue	West Africa
CarbonCap	CarbonCap focuses on decarbonization projects to meet the net-zero goal.	Link	Data not available	Data not available

6.3 Factors affecting carbon price development

TABLE 3: OVERVIEW OF KEY DEMAND-SIDE RISKS THAT CAN IMPACT PRICING OF NBS VERIFIED EMISSION REDUCTIONS

DEMAND-SIDE RISK FACTORS	LIKELIHOOD OF IMPACT ON VER PRICING		TYPE OF IMPACT
	UNTIL 2030	UNTIL 2040	
Exclusion of removal offsets within SBTi guidance to achieve net zero in target year	Low	Low to medium	The SBTi supports the use of removal offsets for emissions that cannot be abated. We estimate that there is a very low risk that this will change. It is more difficult to assess subsequent years. Downward effect on demand for VERs generated by NBS removal activities as companies re-evaluate the role neutralization must play in net-zero strategies.
Dominance of other net-zero standards/corporates that exclude use of offsets	Low	Medium	Dampening effect on demand for VERs of all types as companies shift to other standards/claims. These may include moves to include removal enhancements as part of the GHG Protocol Scope 3 reporting, pushing the market towards "insetting" rather than offsetting.
Technology-based removals become commercially viable	Low	Medium	Downward effect on demand for VERs of all types as technology-based removals can directly reduce value chain emissions, and therefore compete with offsets. It is unlikely that technology-based removals will be commercially viable at scale before 2030. Moreover, they will not be the right solution for all sectors and may face their own permanence risks.
Exclusion of any offset type within SBTi guidance on voluntary offsetting	Low to medium	Medium	Dampening effect on demand for both NBS and non NBS credits. The SBTi currently has a considerable impact on shaping the discussion on the role offsets play. This is especially relevant for the large EU and US multilaterals, which make up a large share of the MSCI All Country World Index.
Public opinion at scale questions the credibility of offsetting	Medium	Medium	Strong downward effect on demand for VERs of all types. In a situation where carbon neutrality claims backed by VERs become perceived as a form of greenwashing by the public at large, companies will move away from the market, posing a risk that a rapidly growing market will become oversupplied.

TABLE 4: OVERVIEW OF SUPPLY-SIDE RISKS THAT CAN IMPACT PRICING OF NBS VERS

SUPPLY-SIDE RISK FACTORS	LIKELIHOOD OF IMPACT ON VER PRICING		TYPE OF IMPACT
	UNTIL 2030	UNTIL 2040	
Credit-crunch-type event on NBS removal buffers triggered by climate events or policy decisions	Low to medium	Medium	Shock in the market due to the depletion of permanence buffers and integrity questions about NBS removals. Lasting impact on the voluntary market given environmental integrity concerns.
Sector-wide carbon pricing instruments encroach on activities covered by the VCM	Low to medium	Medium	Upward pressure on VER pricing as supply (especially non-NBS) may become restricted, while demand may further grow if schemes allow for the use of VERs to meet part of the obligations.
Exclusion of non-NBS activities on grounds of additionality	Low to medium	Medium	Upward pressure on VER pricing for NBS as supply from non-NBS activities phases out earlier than expected, or demand for remaining credits wanes, resulting in fewer non-NBS VERs for sale.
Onset of corresponding adjustments to VCM transactions	Medium	Medium	Upward pressure on VER pricing of all types due to ensuing supply squeeze. However, the severity of this impact would depend on whether corresponding adjustments are only implemented in high/middle-income countries or all governments.
Evolving nesting requirements and changing rules under major standards like VCS for REDD projects	Medium to high	High	Upward pressure on VER pricing as part of the NBS supply may be restricted. The nesting of REDD+ projects will likely lead to substantial haircuts to many existing REDD projects and lower than current average volumes from future REDD+ activities. This might trigger additional demand for NBS removals if buyers continue to show preference for NBS VERs.

6.4 Theoretical approaches for measuring the co-benefits of blue carbon projects

TABLE 5: OVERVIEW OF THEORETICAL APPROACHES TO MEASURE CO-BENEFITS IN BLUE CARBON PROJECTS

CO-BENEFIT CATEGORY	EXAMPLES	MEASUREMENT APPROACH
Economic	Family incomes, regional incomes	Ex-ante (for example, Regional Economic Stability Analysis[91]) and/or ex-post economic valuation
Social	Employment, education, health, well-being	Qualitative social analysis[92]
Environmental	Water resources, biodiversity	Observational and/or GIS analysis Environmental valuation methods such as Travel-Cost Method, Opportunity Cost Method, or Hedonic Price Method[93]

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APRIL 2023

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