



THE ABU DHABI **BLUE CARBON** DEMONSTRATION PROJECT

Building Blue Carbon Projects - An Introductory Guide



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Blue Ventures	Ministry of Marine Affairs and Fisheries, Republic of Indonesia (BALITBANG KP)
Carbon Manna Africa	The Government of Seychelles
Climate Change Research Group	The Ocean Foundation
Earthwatch Institute	United Nations Environment Programme (UNEP)
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Duke University	
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Building Blue Carbon Projects

An Introductory Guide

This report is a product of the Abu Dhabi Blue Carbon Demonstration Project

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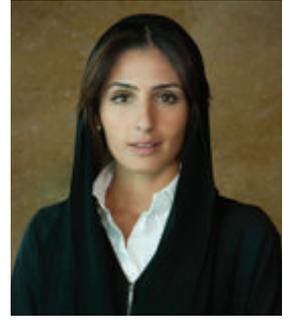
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1.5 Status of Blue Carbon Science	Environmental Science Associates
1.6 - 2.1 Status of Blue Carbon Policy - Economic and Financial Considerations	Forest Trends
2.2 Institutional Considerations	Climate Change Research Group and Forest Trends
3 - 3.2 Blue Carbon Projects - Conducting A Blue Carbon Scoping Study	GRID-Arendal
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8.4 An Integrated Blue Carbon Program for the Indonesian Archipelago	Ministry of Marine Affairs and Fisheries-Indonesia (BALITBANG KP), Agency for Research and Development of Marine and Fisheries
8.5 Exploring Seagrass Climate Change Mitigation Potential in Thailand and Australia	International Union for Conservation of Nature (IUCN)
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◆ Preface



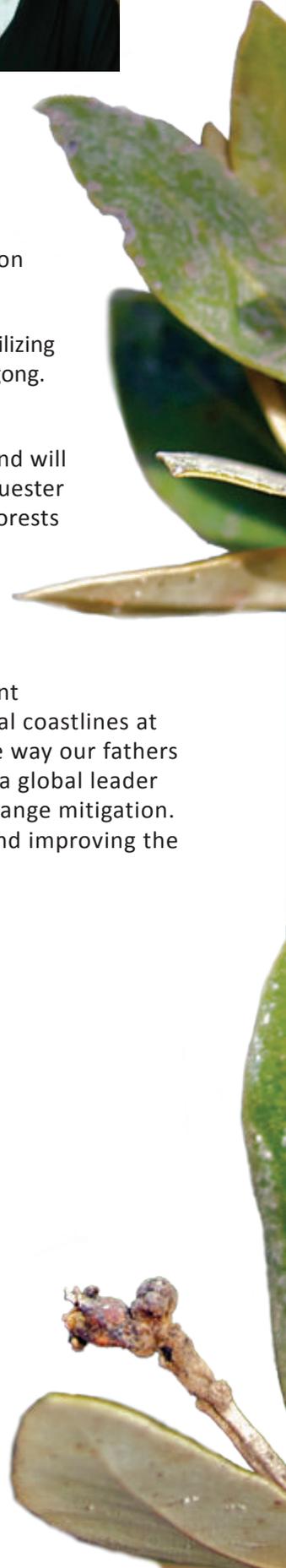
Marine and coastal ecosystems and mangroves in particular, are an important heritage for Abu Dhabi and continue to be of high intrinsic value to the people of the Emirate. These environments represent the legacy of the late HH Sheikh Zayed, who prioritized conservation and harnessed the cultural value of mangroves as a driver for conservation.

Today, we also value them for the broad range of services these ecosystems provide, such as stabilizing our coastlines, filtering our water, and providing habitat to fish and iconic species such as the Dugong. Most importantly perhaps, we simply enjoy their presence, and so do the visitors to the Emirate.

At a time where anthropogenic climate change is starting to impact lives around the globe, and will increase doing so, it is ever more important to ensure that these ecosystems continue to sequester and store atmospheric carbon. As an intervention of the Global Environment Facility's Blue Forests Project, Abu Dhabi is an essential partner in one of the largest Blue Carbon undertakings to date. At the same time, the Demonstration Project is a cornerstone of the Eye on Earth's Special Initiative on Oceans, which is aimed at capturing and applying data to enhance local capacity for conserving marine environments.

Abu Dhabi has undergone unprecedented economic development and is today very different from how it used to look just half a century ago. Yet, we take pride in conserving our natural coastlines at the same time, ensuring our children and grandchildren will benefit from them in the same way our fathers have and we do. As countries migrate towards greener economies, Abu Dhabi is becoming a global leader in understanding and facilitating the linkages between coastal management and climate change mitigation. We understand that mangroves and the full coastal ecosystem are critical to maintaining and improving the sustainability of our Emirate and beyond.

Razan Khalifa Al Mubarak
Secretary General
Environment Agency - Abu Dhabi (EAD)





◆ Foreword



Globally, coastal and marine ecosystems are under significant threat, and the rates of their loss are alarming. Through the advancement of science, and an increased focus on drivers for and effects of climate change, these ecosystems' role in sequestering and storing carbon has received growing attention. 'Blue Carbon', the recognition of this ecosystem service, is a concept that could become the catalyst for the protection and restoration of our natural coastal and marine environments, and the conservation of associated services including and beyond carbon.

EAD and AGEDI have strategically invested their efforts into supporting the advancement of Blue Carbon in Abu Dhabi and beyond. Through the Abu Dhabi Blue Carbon Demonstration Project, we have gained highly valuable insights into our own Blue Carbon ecosystems, the roles they play for our society and economy, and options to ensure their continued existence. Through this Introductory Guide, we hope to make our experience, as well as that of other initiatives around the planet, available to those who embark on applying the Blue Carbon concept to protect their mangroves, seagrass meadows, and saltwater marshes.

Ahmed Abdulmuttaleb Abdulla Baharoon
Acting Director
Abu Dhabi Global Environmental Data Initiative (AGEDI)
Environment Agency - Abu Dhabi (EAD)





Introduction and Context

Blue Carbon is a term used to describe the climate change mitigation benefits of preserving, protecting, and restoring coastal habitats such as mangrove forests, seagrass meadows, and saltwater marshes (Nellemann *et al.*, 2009). Blue Carbon is a recent concept that joins the fields of marine and coastal management and climate change science. This text considers a Blue Carbon project as one that uses the climate change mitigation value of marine and coastal ecosystems to support their conservation, sustainable use, and restoration. All Blue Carbon projects are essentially 'new' and can present a complex and daunting endeavour for project implementers, whether they are from governments, civil society, or the private sector. Demonstrating Blue Carbon and implementing project results are challenging goals as they go beyond business as usual in order to create and understand and secure carbon and coastal ecosystem benefits.

This introductory guide, a product of the Abu Dhabi Blue Carbon Demonstration Project, aims to stimulate discussion regarding projects that support the conservation and restoration of coastal ecosystems based on a Blue Carbon approach. It serves as a snapshot of potential common Blue Carbon project elements based on existing projects and an introduction of key issues for consideration. This guide is intended to complement existing Blue Carbon materials and reports (many of which links are provided for throughout this text) and potentially stimulate subsequent guides that will support Blue Carbon project development.

Many questions are raised when discussing potential Blue Carbon projects with national representatives and other interested parties. Dispersed throughout the text are some responses to one of the most common questions, which, though simple, can be difficult to answer - why is Blue Carbon important?

Target audience

The target audience of this introductory guide is the range of potential project proponents interested in applying Blue Carbon values through the development of Blue Carbon projects to mitigate climate change and support coastal ecosystem management to enhance natural resource values. Such proponents might include government officials in relevant Ministries and Agencies, universities, project development professionals and managers, and private sector representatives who may be looking for opportunities to strengthen their corporate social responsibility initiatives.

What this report is not

This introductory guide is not intended as a prescriptive 'manual' or 'template' for Blue Carbon projects. It is still early days for application of the Blue Carbon concept, so there is much to learn and one project type will never fit all settings. Individual projects will necessarily conform to unique national settings and priorities, including ecological, social, and political conditions, geographic context, availability of funding, and other factors.

Key Messages and Recommendations

1. Even though the application of Blue Carbon principles is in the introductory phase there are strong indications that **Blue Carbon projects can work** to fulfil the dual climate change mitigation and enhanced coastal ecosystem value purposes. It is being recognised in coastal ecosystem policy and management in Abu Dhabi and applied in the first registered Blue Carbon project in Kenya (both are discussed in this guide).
2. There is **no rigid template for Blue Carbon projects** and there should not be: A flexible approach to project development best suits the varying conditions and objectives of potential projects around the world, even as some common global metrics should be developed for monitoring and evaluation.
3. Potential **Blue Carbon projects need to have a high likelihood of sustainability and success** for improving ecosystem management through offset generation, conservation agreements, or other mechanisms that apply the value of Blue Carbon and use it for the benefit of coastal ecosystems over the long term.
4. **Clear objectives and stakeholder expectations** for Blue Carbon projects should be identified early in the project planning process. It is important not to oversell the potential financial viability of a Blue Carbon project.
5. Blue Carbon project planning and implementation process must include **constant engagement with stakeholders** to keep partners informed about project progress, especially regarding policy and management activities.
6. Project success and longevity can be better assured if in-country project proponents are equipped with relevant skills: **Blue Carbon capacity building** should be prioritized across all levels, ranging from field scientists and local community organization to the private sector and government representatives.
7. It will be most useful to global coastal management strategies if the data produced from Blue Carbon projects is **comparable to data** produced by other international restoration and protection efforts, especially if it is hoped that Blue Carbon concepts can be introduced to such efforts.
8. The option of **combining Blue Carbon with other ecosystem services valuation** should be kept open to provide multiple potential values that can support conservation activities.
9. Blue Carbon project developers have the opportunity to **learn from** the challenges and successful outcomes from **REDD+** projects that feature similar project elements.
10. A **'ridge to reef' approach** for Blue Carbon projects could help protect connected corridors between Blue Carbon habitats and coral reefs and maintain the resilience and productivity of greater marine and coastal ecosystems.



Image credit K Fuller/Marine Photobank

1 What is Blue Carbon?

The marine biosphere is a major component of the global carbon cycle, responsible for roughly half of the annual photosynthetic absorption of the greenhouse gas (GHG) carbon dioxide (CO₂) from the atmosphere (Field *et al.*, 1998, adapted from Lutz *et al.*, 2007). **Blue Carbon** is a concept that describes the carbon linked to the marine biosphere through coastal and marine ecosystems. These ecosystems aid in mitigating climate change by actively sequestering carbon from the atmosphere and also by providing natural carbon storage in biomass and sediments. The Blue Carbon concept is currently focused on three key coastal ecosystems: mangrove forests, saltwater marshes, and seagrass meadows (Laffoley and Grimsditch 2009, Nellemann *et al.*, 2009).

Coastal Blue Carbon ecosystems have been found to be highly efficient at storing and sequestering carbon. Figure 1 illustrates where carbon is stored in Blue Carbon ecosystems: in plant biomass and below the surface in sediments. The carbon-rich soils associated with Blue Carbon habitats can represent significant carbon accumulation, with up to five times more carbon stored in these soils than in the soils of terrestrial forests (Donato *et al.*, 2011, Fourqurean *et al.*, 2012).

In addition to Blue Carbon, coastal and marine ecosystems provide a wide range of other important ecosystem services, such as climate change adaptation, water filtration, shoreline stabilisation, storm and flood protection, sustaining biodiversity, and habitat provision for commercially and recreationally important species of fish and shellfish, as well as iconic species. Equally important, but complex to value monetarily, intact ecosystems provide recreational benefits and have spiritual values for the local community as well as visitors. In general, they also help sustain the livelihoods and cultural heritages of the communities that rely on healthy coastal and marine ecosystems. The conservation of Blue Carbon ecosystems is significant to climate change mitigation and adaptation strategies, will support overall ecosystem resiliency and help sustain important ecosystem service values. It represents a comprehensive ecosystem approach to management.

Key takeaways:

- When healthy, Blue Carbon ecosystems store and sequester carbon helping to mitigate climate change, help safeguard biodiversity, and are also vital to many coastal and island communities through the numerous important ecosystem services they provide.
- When degraded, Blue Carbon ecosystems contribute to climate change by releasing stored greenhouse gases (GHG) into the atmosphere and providing fewer ecosystem services.

A Blue Carbon project aims to use the climate change mitigation value of marine and coastal ecosystems to support their conservation, sustainable use, and restoration

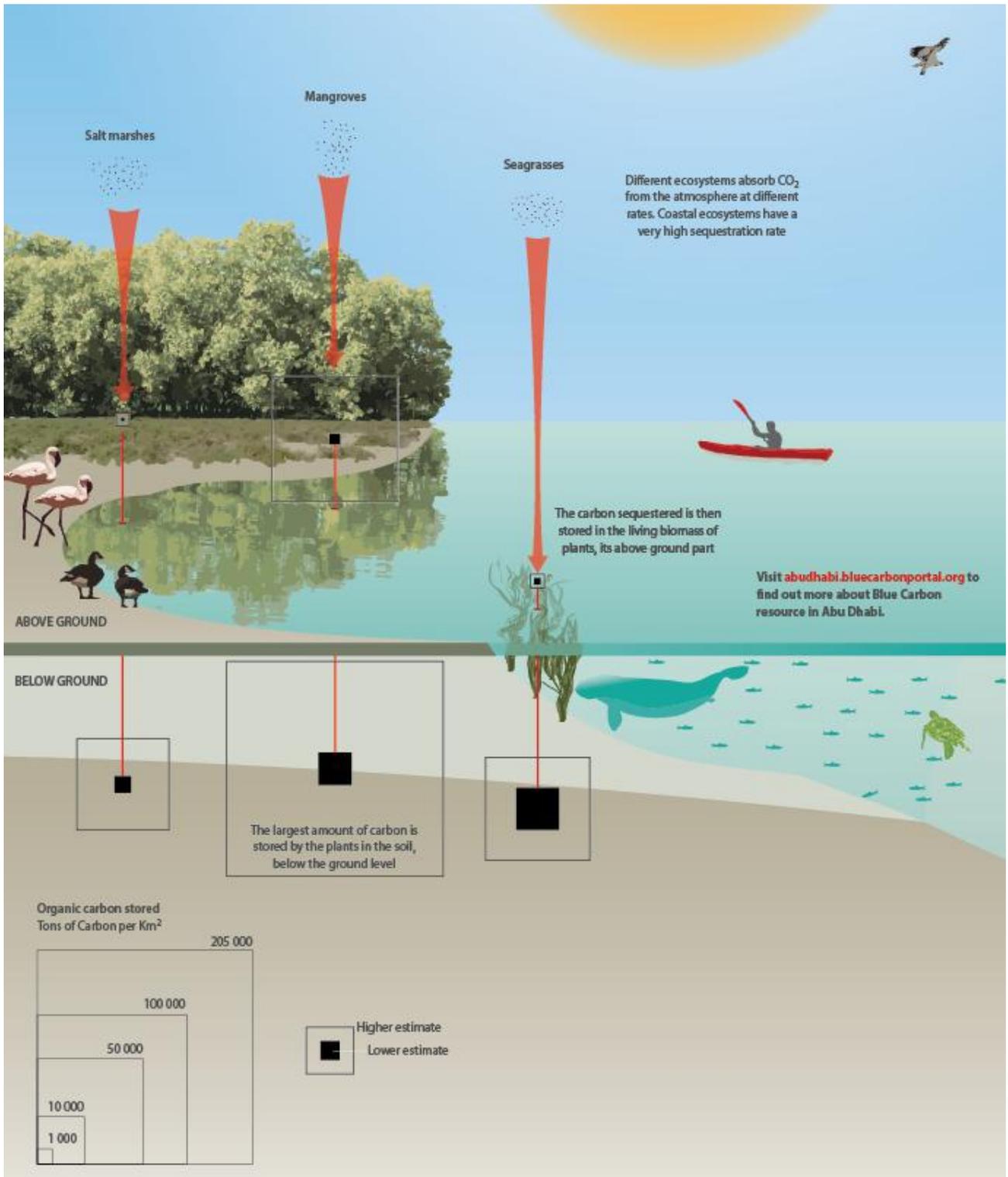


Figure 1 Coastal Blue Carbon ecosystems store and sequester carbon (Sources: Schile *et al.*, in Preparation. Figure credit AGEDI - Riccardo Pravettoni/GRID-Arendal).

1.1 Blue Carbon Ecosystems

The Blue Carbon concept is currently focused on the following three marine and coastal ecosystems: mangrove forests, saltwater marshes, and seagrass meadows.

Mangrove Forests

Mangrove forests are found within intertidal areas of tropical and subtropical regions. Mangroves are a type of salt-tolerant vegetation that includes trees and shrubs with extensive below-surface root structures and deep sediments. These deep layers of sediments store anaerobic carbon that when exposed, oxidize and become a source of greenhouse gas (GHG) emissions. Up to the equivalent of 3,754 tons of carbon per hectare has been found in the first meter of soil for intact mangrove forests (Donnato *et al.*, 2011). However, the carbon stocks of mangrove forests are not uniform. The depth of carbon-rich soil relates to the geomorphology of an environment, and there are differences in carbon storage between estuarine and oceanic mangroves where the substrate material differs. Despite the variations however, mangroves remain among the most carbon-rich forest environments (Sifleet *et al.*, 2011).

“The survival of the mangroves in the coastal ecosystem is the key to preserving sustainability in our emirate and to guarantee a better environmental future.”

H.E. Razan Khalifa Al Mubarak
Secretary General, Environment
Agency Abu Dhabi (EAD)

In addition to their role in carbon sequestration, mangroves provide a host of other ecosystem services. Their extensive root structures provide shelter and habitat for commercially and recreationally important fish and shellfish, as well as filtering sediments and pollutants from water, improving its overall quality. Their presence also provides a buffer between shores and incoming storms, and they aid in keeping soils in place, preventing shoreline erosion. Increasingly mangroves provide a source of revenue derived from ecotourism, linked with recreational and spiritual values, as well as providing natural resources to indigenous communities residing in mangrove-rich coastal areas. Mangroves also provide fuel for cooking (e.g., charcoal) and construction materials (e.g., wood). Mangrove ecosystem services alone – excluding carbon cycling – have been valued at U.S. \$193,845 per hectare of intact ecosystem (De Groot *et al.*, 2011).

Saltwater Marshes

Saltwater marshes are primarily found in temperate regions, within intertidal zones, and contain partially and fully submerged vegetation suited to both fresh and salt water. These ecosystems provide habitat for a variety of wildlife including fish, shellfish, invertebrates, and numerous bird species, both commercially and recreationally important.

It is estimated that salt marshes contain between 900 and 1,700 tons of carbon per hectare, with an approximate yearly habitat loss of up to two percent (Sifleet *et al.*, 2011). When healthy, saltwater marshes also filter nutrients and sediment from passing water, protect against wave

damage and erosion, and diminish flooding by holding excess storm waters. Their presence also aids in regulating water levels during periods of dry weather.

Seagrass Meadows

Seagrasses are fully submerged flowering plants that can grow in meadows and are found in the near-shore coastal areas of all continents except Antarctica. Seagrass roots accumulate vertically beneath the seafloor over time, creating a significant store of buried carbon. It is estimated that a hectare of seagrass meadow, even with its small living biomass, may hold as much carbon as one to two hectares of temperate forest (Murray *et al.*, 2011). Of the three coastal ecosystems key to Blue Carbon, seagrasses are currently the least well-studied and thus present an area for significant exploration and knowledge expansion.

Similar to mangrove forests and saltwater marshes, seagrass meadows provide important ecosystem services such as habitat for many species of fish and invertebrates. They also provide water filtration services, by holding nutrients and sediment in their grassy biomass. Recently it has been suggested that seagrass restoration projects could effectively mitigate climate change while providing returns at least equal to the initial project investment needed, assuming an appropriate carbon tax was in place (Duarte *et al.*, 2013).



Coastal Blue Carbon ecosystems include mangrove forests, seagrass meadows and saltwater marshes (image credit from left to right: Florida Keys mangroves - Riandi/Wikimedia Commons; Belize seagrass meadow - Steven J Lutz, GRID-Arendal; Carpinteria Salt Marsh Reserve - Gerick Bergsma/Marine Photobank).



Potential areas for further research into Blue Carbon ecosystems and scientific discovery may include marine vertebrates and algal mats (image credit from left to right: schooling Trevally off the Great Barrier Reef - Catlin Seaview Survey/Underwater Earth; cyanobacterial algal mats of Abu Dhabi - image credit AGEDI/Pat Megonigal).

Other Ecosystems

Although mangroves, saltwater marshes and seagrasses are the current focus for Blue Carbon, in time, other marine ecosystems may be explored for their carbon values. The 2009 IUCN report titled *The Management of Natural Coastal Carbon Sinks* discusses kelp forests and coral reefs as potential carbon sinks (Lafoley and Grimsditch, 2009) (discussed further in Section 5). Recent research and publications suggest a potential marine carbon sequestration role for the conservation and restoration of marine vertebrate populations, including fish stocks and marine mammals (Arnason *et al.*, 2008; Pershing *et al.*, 2010; Smith *et al.*, 2010; Lutz, 2011; Saba and Steinberg, 2012; Wilmers *et al.*, 2013; Irigoien *et al.*, 2014). Additionally, there may be other currently unknown candidate or potential blue carbon ecosystems. For example, the United Arab Emirates (UAE) is home to large areas of salt flats that were explored for their Blue Carbon potential during the Abu Dhabi Blue Carbon Demonstration Project. The project also found noteworthy results related to the carbon stored in the Emirate's algal mats, which are described in Case Study 8.1. To-date, algal mats and marine vertebrates have not been rigorously explored for their connection to climate change mitigation and a scientific consensus on their consideration as part of 'Blue Carbon' is lacking. They do present however, significant candidate areas for further research into Blue Carbon.

Key takeaways:

- The international community currently considers mangroves, salt marshes, and seagrasses as 'Blue Carbon' ecosystems that provide value for climate change mitigation.
- Further fields for Blue Carbon may include marine vertebrates, kelp, and algal mats.

Blue Carbon projects can work!

Strong signals from the UAE and Kenya indicate that Blue Carbon is being recognized for the first time in marine and coastal ecosystem policy and management, including at national and local scales, and can achieve the dual goals of climate mitigation and improved and sustainable marine and coastal ecosystem management.

Significant results from the Abu Dhabi Blue Carbon Demonstration Project to date include the following (illustrated further in Case Study 8.1):

- Project findings are being recognized in policy and management through:
 - incorporation into Abu Dhabi's National Biodiversity Strategies and Action Plans (NBSAP) report;
 - incorporation into the Abu Dhabi Environmental Performance Index (AD-EPI) report;
 - incorporation into Environment Agency Abu Dhabi (EAD) business planning towards the Climate Change programme;
 - incorporation into the Abu Dhabi 2030 Urban Structure Framework Plan (Abu Dhabi Capital 2030), planning for the Al Gharbia Region (Al Gharbia 2030) and marine spatial plans; and
 - utilization by the Abu Dhabi municipality.
- The Abu Dhabi Global Environmental Data Initiative (AGEDI) will continue the exploration of Blue Carbon in the Northern Emirates; and
- The Emirate of Dubai will utilize the methodology and ecosystem services habitat protocols of the project in carrying out similar assessments.

Significant results to date from the Mikoko Pamoja project in Gazi Bay, Kenya, include the following (illustrated further in Case Study 8.2):

- An agreement was successfully negotiated with the local community regarding the allocation of money generated by the sale of Blue Carbon credits, with approximately two thirds identified for the conservation of mangroves and for community benefit;
- The Kenyan Government has supported local rights and authority regarding Blue Carbon through the issuing of a Forest Management Agreement to the Gazi Bay community; and
- The project has successfully completed verification and awaits Plan Vivo certification to start Blue Carbon offsetting.

These results present excellent lessons learnt and targets for the further application of Blue Carbon through other international projects and initiatives.

1.2 The Need for Blue Carbon

Despite the many important ecosystem services they provide, Blue Carbon ecosystems are quickly disappearing across the globe. It is estimated that 67 percent of global mangrove habitat has been lost (Murray *et al.*, 2011) and the annual rate of their degradation and destruction is occurring at 0.7% to 2.1% for mangrove forests, 1% to 2% for saltwater marshes, and 1.2% to 2% for seagrass meadows (Murray *et al.*, 2012). If this rate continues, it is estimated that 30 to 40% of saltwater marshes and seagrasses and nearly 100% of mangroves could be lost in the next 100 years (Pendleton *et al.*, 2012).

Often mangroves are drained and converted for agricultural uses or for shellfish aquaculture. Overexploitation of mangrove timber, terrestrial logging and agricultural activities upstream and coastal development are also drivers for habitat loss. Saltwater marsh ecosystems have been long converted for agricultural use or lost to coastal development, and are increasingly under pressure from sea level rise. Seagrass meadows are threatened worldwide with impacts including coastal development and agriculture that generate pollutant- and sediment-heavy runoff, and dredging and construction activities. When Blue Carbon ecosystems are degraded, their formerly submerged soils and roots can become exposed, causing the carbon within them to become oxidized to greenhouse gasses (Pendleton *et al.*, 2012).

Worldwide, the degradation and loss of these ecosystems presents a crucial need to take action toward effectively managing remaining Blue Carbon ecosystems and where possible, to restore what has been lost. This is important to the coastal communities in the vicinities of these ecosystems, mangroves and tidal marshes in particular, where economic livelihoods are closely linked to ecosystem health.

Although a comparatively young field, research has already quantified the importance of Blue Carbon ecosystems, and their greenhouse gas dynamics are now better understood. Payment for ecosystem services schemes such as carbon offsets in both the regulatory and voluntary market provide a central incentive for Blue Carbon ecosystem conservation and restoration, as do other mechanisms including compensation funds, national carbon accounting and reporting, and the green economy approach. Ecosystem services beyond carbon sequestration and storage may give further value to ecosystems and positively contribute to management frameworks and actions.

"Coastal communities and island states with coastal and marine ecosystems rich in Blue Carbon need support from the international community to evaluate the contribution these make towards carbon sequestration at the national level. Once the value per country is known, governments will be in a stronger position to make a case to protect these ecosystems and garner support for these carbon stocks to be included in the carbon trading mechanism. Without knowledge of the true value of Blue Carbon stored within a country's EEZ and without the necessary financial and technical support Blue Carbon ecosystems, as important as they are, will remain undervalued and threatened by development."

Professor Rolph Payet
Minister of Environment and Energy
Republic of Seychelles

Key takeaways:

- Blue carbon ecosystems are experiencing degradation and loss across the world.
- Blue Carbon projects use the value of climate change mitigation to support the conservation, sustainable use, and restoration of coastal and marine ecosystems.



Healthy Blue Carbon ecosystems provide many important ecosystem services, including the storage and sequestration of atmospheric carbon, thereby helping to mitigate climate change. Degraded Blue Carbon ecosystems, such as these deforested mangroves in Vatoava, Madagascar, provide fewer ecosystem services and can release stored greenhouse gases (GHG) into the atmosphere, thereby contributing to climate change (image credit and © Garth Cripps, Blue Ventures).

1.3 Global Context of Blue Carbon

Blue Carbon may offer governments and the private sector the possibility to enhance efforts to meet their commitments and priorities with regards to the environment, sustainable development and climate change mitigation. Blue Carbon projects can run in concert with and complement national legal frameworks and policies regarding the management of Blue Carbon ecosystems and with international efforts and commitments on biodiversity conservation and climate change mitigation. Examples at the national and international scale are provided in the following:

Consistency with national efforts

- Blue Carbon concepts can be readily integrated with national environmental management strategies - especially those for protecting and restoring national biodiversity, ecosystem based management (EBM), coastal zone management, and coastal and marine protected area planning.
- Blue Carbon can support national efforts regarding the calculation of natural capital valuation and determination of values for compensation purposes by assessing the valuation of ecosystems services for coastal environments
- Blue Carbon can support national efforts regarding climate change, including the promotion of environmental quality and policies and strategies for mitigating and adapting to climate change and reduce the carbon footprint.
- Blue Carbon concepts can support economic stability that is derived from well-managed coastal resources by conveying the value of those mangroves, seagrass meadows and coastal marshes to local communities and to national interests, along with maintaining their existing support for healthy fisheries and stable coastal systems.
- Blue Carbon can help meet national goals regarding conservation and sustainable coastal development, including land use planning nationwide with an emphasis on coastal areas and the integration of environmental priorities into development programs.
- Blue Carbon can improve the livelihoods of local communities by providing both income opportunities and subsistence resources.
- Blue Carbon can be a valuable mechanism to involve the private sector in conservation efforts through corporate social responsibility schemes (i.e., Plan Vivo Certificates traded on the voluntary carbon market).

“We strive to inform the higher levels of government about the scientific perspectives and the ecological importance of Blue Carbon ecosystems. We are making the case clear to the upper levels of government that Indonesia needs to coordinate and take Blue Carbon further.”

Andreas Hutahaean, PhD
Head of the Research Group on
Blue Carbon, Ministry of Marine
Affairs and Fisheries-Indonesia

Consistency with international efforts:

- **UNFCCC** - Convention Article 4.1(d) of the United Nations Framework Convention on Climate Change (UNFCCC) states that all parties shall:
 - “Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, **including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems.**” (UNFCCC, 2013).
- **UN REDD+** - The UN Reducing Emissions from Deforestation and Forest Degradation programme (REDD) is a UNFCCC mechanism to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. "REDD+" goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (UN-REDD, 2013). Blue Carbon can support national efforts to develop national REDD+ strategies by providing inputs of mangrove carbon and forestry assessment database to feed into National REDD+ frameworks and “national and regional REDD+ readiness plans and activities” (Ajonina *et al.*, in press).
- **Nationally Appropriate Mitigation Actions** - Following negotiations pursuant to the 2007 Bali Action Plan and as part of the agreed outcome of the 2012 UNFCCC meeting in Doha (COP 18), developing country Parties will take Nationally Appropriate Mitigation Actions (NAMAs). NAMAs are voluntary measures for mitigating GHG emissions in the context of sustainable development, supported and enabled by technology, financing and capacity-building, aimed at achieving reduced emissions (UNFCCC, 2013). The International Blue Carbon Policy Working Group’s recommendations for Blue Carbon and the NAMA processes include the following (International Blue Carbon Initiative, 2012):
 - Develop coastal wetland NAMAs or include Blue Carbon ecosystems in broader NAMAs and prepare for implementation (including technical, policy and institutional aspects);
 - Provide cost estimate (incremental costs) for developing and implementing national blue carbon NAMA for countries with an obligation for self-financed NAMAs; and
 - Explore opportunities to include Blue Carbon as part of adaptation activities.
- **Convention on Biological Diversity** - Each Party to the Convention on Biological Diversity (CBD) have been called upon to develop national strategies for the conservation and sustainable use of biological diversity. In 2010, the Convention revised its Strategic Plan which included the Aichi Biodiversity Targets. These targets identify goals for the period of 2011 - 2020. Aichi targets that Blue Carbon projects may directly contribute to include the following:
 - Target 7, regarding sustainable management and conservation of biodiversity;
 - Target 11, regarding systems of protected areas and other effective area-based conservation measures;
 - Target 14, regarding commitment to the provision of ecosystems services; and
 - Target 15, regarding enhancing ecosystem resilience and the contribution of biodiversity to carbon stocks and climate change mitigation.

- *Ramsar Convention on Wetlands* - The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (Ramsar, 2013). Opportunities for Blue Carbon under the Ramsar Convention could include:
 - Allowing convention parties to access funding to implement relevant Resolutions for coastal Blue Carbon conservation through multilateral & bilateral processes (e.g. the Global Environment Facility (GEF)). Ramsar's Small Grant Programmes could also be an opportunity to support pilot projects in the ground (International Blue Carbon Initiative, 2012); and
 - Include Blue Carbon to the criteria for identifying wetlands of international Importance.

Further information on the national and international context of Blue Carbon can be found in the following and in Sections 1.6 and 7:

Coastal Blue Carbon as an Incentive for Coastal Conservation, Restoration and Management: A Template for Understanding Options (Emmett-Mattox and Crooks 2013)

http://www.estuaries.org/images/blue%20carbon%20template_final.pdf

Guidance for national blue carbon activities: fast-tracking national implementation in developing countries (International Blue Carbon Initiative, 2012)

http://thebluecarboninitiative.org/wp-content/uploads/BCPWG_NationalRecs_small.pdf

Incorporating Blue Carbon as a Mitigation Action under the United Nations Framework Convention on Climate Change: Technical Issues to Address (Murray and Vegh, 2012)

<http://nicholasinstitute.duke.edu/sites/default/files/publications/blue-carbon-unfccc-paper.pdf>

Options for Blue Carbon within the International Climate Change Framework (Grimsditch, 2011)

<http://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?article=1465&context=sdlp>

Opportunities to Use Carbon Services to Advance Coastal Habitat Conservation (NOAA, 2011)

http://www.ecosystemcommons.org/sites/default/files/coastal_blue_carbon_report_to_nocc_061311.pdf

Key takeaways:

- Blue Carbon can support a wide range of national efforts in the sustainable use, management and conservation of coastal environments.
- Blue Carbon can support international commitments, such as in the fields of climate change mitigation and biodiversity conservation.

1.4 Improving Coastal Ecosystem Management through Blue Carbon

While there seems to be a general notion that Blue Carbon projects are directly linked to generating carbon offsets, or another financial return, that is not necessarily the case. A Blue Carbon project explores the climate change mitigation value of a coastal ecosystem in order to motivate its improved management. Payments for Ecosystem Services (PES) schemes such as carbon offsets in both the regulatory and voluntary market provide a central incentive in this context. However, other mechanisms may also support improved ecosystem management such as conservation agreements and or the recognition of the value of Blue Carbon in existing and new policy and management. Figure 2 proposes five potential pathways to use the value of Blue Carbon to improve coastal ecosystem management, conserve Blue Carbon ecosystems, support sustainable livelihoods and address climate change.

Additionally, the valuation of ecosystem services beyond carbon sequestration and storage may give further incentives for improved ecosystem management, and may be a significant factor for management frameworks and actions (discussed further in Section 4).

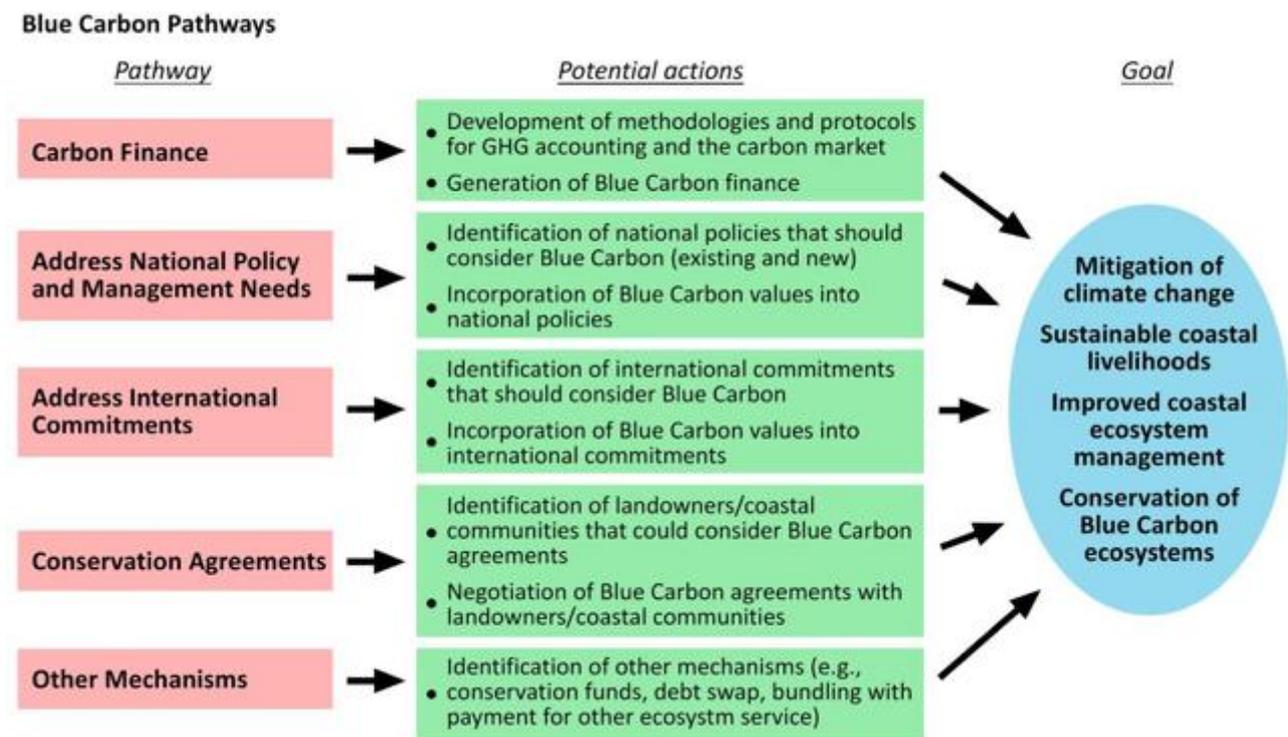


Figure 2 Five potential pathways to use the value of Blue Carbon (developed from NOAA, 2011).

Carbon finance is briefly discussed in the following and Section 2. Examples of potential national and international Blue Carbon relevant policies are provided in Section 1.3. Combining Blue Carbon with the valuation of other ecosystem services is discussed in Section 4. Other potential Blue Carbon mechanisms and pathways such as conservation agreements, funds and debt-for-nature swap remain to be explored.

Carbon Finance

Carbon offsetting is a well-known method of financing conservation by allowing an entity to purchase the ability to compensate for their carbon pollution in exchange for carbon not being emitted elsewhere (as it would otherwise have been). In this context, Blue Carbon ecosystems are kept intact, restored or managed to secure and increase their carbon stocks. Carbon financing involves different standard-setting organisations that provide guidance on developing projects for carbon trading and bring validity to projects by ensuring they meet certain (often robust) criteria. An exception being Plan Vivo, which is specifically designed for small-scale community projects, not for producing offsets that will be traded in a market as it is the case for Verified Carbon Standard credits, etc.).

Blue Carbon project's need to address the issue of additionality, which, aims to ensure that the project's implementation is motivated primarily by the potential for receiving payments for the carbon credits (versus an activity that would have been undertaken regardless). Further, there needs to be assurance that the project will endure and not result in increased carbon dioxide or other greenhouse emissions elsewhere (i.e., permanence and leakage), defined as follows (adapted from Overseas Development Institute, undated):

Additionality is the requirement that the carbon emissions after the implementation of a Blue Carbon project are lower than those that would have occurred in the most plausible alternative scenario to the implementation of the project.

Permanence refers to the risk that emission removals by afforestation or reforestation activities are reversed because Blue Carbon ecosystems (mangrove forests) are cut down or destroyed by natural disaster.

Leakage refers to the risk that a Blue Carbon offset project displaces activities that create emissions outside the boundaries of the project.

Key takeaway:

- There may be more than one pathway to use the value of Blue Carbon to mitigate climate change and improve coastal ecosystem management or achieve other project goals
- Additionality, permanence, and leakage should be explored to ensure that projects are being considered for their likelihood in generating carbon credits, their sustainability, and for preventing emissions elsewhere.

1.5 Status of Blue Carbon Science

Over recent years there has been an expansion of coastal science from investigating the role of carbon and nitrogen in terms of ecosystem productivity, and in the analysis of coastal wetland resilience in terms of sea level rise, to the role of evolving and disturbed coastal ecosystems in the global carbon cycle. This resulted from an evolving awareness about the role coastal ecosystems could play an important role in climate change adaptation and mitigation strategies. Intact coastal ecosystems slowly but continuously remove carbon dioxide from the atmosphere and store it in

soils at a rate that is impactful over multi-centennial time scales. Now it is recognized that the anthropogenic emissions of carbon dioxide resulting from conversion and disturbance of vulnerable carbon stock is meaningful in a decadal-scale. What followed was an imperative to understand coastal wetlands in the climate change context.

As a result, and at an accelerating pace, the synthesis of science on ecosystem processes is being coupled with new, focused investigations of coastal ecosystem carbon stocks and greenhouse gas flux assessments.

Of the three major Blue Carbon ecosystems, carbon stocks are most well understood for mangrove forests. Remote sensing allows for the mapping of mangrove forest distribution, and thorough analysis of Landsat time series data illustrates the rates of change through time. Research is in the process of linking field-based carbon stocks assessments (including living biomass and soils) to remotely sensed data to map the distribution of carbon pools within mangrove forests. Such investigations have yet to be developed for salt marsh and seagrass ecosystems. By contrast, the understanding of greenhouse gas flux from natural wetlands and disturbed coastal systems is most advanced in investigations of tidal wetland systems.

The status of the science on Blue Carbon and other wetland ecosystems has advanced enough to enable the Intergovernmental Panel on Climate Change (IPCC) to draft methodological guidance on estimating human-induced greenhouse gas emissions and removals from wetlands and drained soils (known as the 2013 Wetlands Supplement (Intergovernmental Panel on Climate Change, 2013)). The availability of these accounting guidelines for coastal wetland management is an important advancement in estimating the human impact on greenhouse gas dynamics in Blue Carbon ecosystems.

Alongside these research advancements, there remain additional areas for expanding scientific understanding. One such example is the further refinement of quantifying the local landscape differences in these fluxes. Additional work is also needed to understand the distribution of vulnerable organic wetland soils, which are hotspots for potential emissions. Addressing remote sensing and mapping needs would aid in quantifying the carbon stocks and fluxes in seagrass and salt marsh ecosystems. Detailed measurements would further the development of models for estimating emissions and removals at the field level.

While more work is needed, the status of the science is sufficient to realize that swift action is required to improve the management of Blue Carbon ecosystems.

Further information on the status of Blue Carbon science can be found in the following:

State of the Science on Coastal Blue Carbon: A Summary for Policy Makers (Sifleetet *et al.*, 2012)

<http://nicholasinstitute.duke.edu/sites/default/files/publications/state-of-science-coastal-blue-carbon-paper.pdf>

2013 Wetlands Supplement (IPCC, 2013)

<http://www.ipcc-nggip.iges.or.jp/public/wetlands/>

Key takeaways:

- Improved understanding of coastal ecosystems in a climate change context has resulted in recent IPCC guidelines on estimating and reporting greenhouse gas emissions from coastal wetlands.
- Recent years have seen an expansion of Blue Carbon science. Mangroves remain the most well-understood, followed by salt marshes. Seagrass ecosystem science has the most room for scientific discovery.
- Knowledge gaps aside, there is enough information to merit the improved management of mangrove, salt marsh, and seagrass ecosystems.



A sediment core is examined as part of Blue Carbon field research in Madagascar (image credit and © Garth Cripps, Blue Ventures).

1.6 Status of Blue Carbon Policy

The development of Blue Carbon policies is relatively recent, with few countries currently having detailed laws and regulations in place to promote the evaluation of environmental services or payments for such services in marine and coastal regions (Climate Focus, 2011)¹.

In general terms, the promotion of Blue Carbon policies is likely to be most effective within the broader context of support for marine spatial planning and ecosystem-based management. Several countries and states are at the forefront of such approaches, including Australia, Belize, Vanuatu, and British Columbia in Canada. Valuable lessons can be learned from their experiences.

While international Blue Carbon policies may emerge in the future, there is currently considerable scope for improving the ability to assess the value of Blue Carbon ecosystem services and to report on these at the national level within the framework of the IPCC requirements. Thus, there is a need for policies that support research on such data information and analysis, and engagement with the IPCC to clarify how best to include Blue Carbon ecosystems within the associated national reporting requirements going forward.

In the short- to medium-term, for those seeking to promote Blue Carbon initiatives with reference to international regulatory frameworks, it is likely to be more productive to do so by including Blue Carbon ecosystems within the development of Nationally Appropriate Mitigation Actions (NAMAs) and or reduced emissions from deforestation and forest degradation, including the role of conservation, sustainable forest management, and the enhancement of forest carbon stocks (REDD+), given that both approaches are already making good progress in multiple country settings.

NAMAs can encompass all Blue Carbon ecosystems, including seagrasses, while REDD+ is limited to mangroves that meets national forest definitions. Where the potential for using a REDD+ approach is applicable, a precursor is the development of a policy that includes mangroves within such national definitions, where appropriate. In many circumstances, it is likely to be more effective to include support for the reduced emissions from mangrove forests within a broader jurisdictional approach, rather than project by project. This approach, referred to as “jurisdictional nested REDD” (JNR), is generating considerable interest on the part of several important climate change actors.

Under either a NAMA or REDD+ approach it should be possible for developing countries to seek access to so called “Fast Start Finance” to support a range of readiness activities and or to implement pilot activities.

Blue Carbon projects can also be promoted with reference to international voluntary carbon markets, where several existing standards and methodologies already include the conservation, avoided deforestation and conversion, and restoration of such ecosystems.

¹Note that the text in this section is a summary of the key messages described in *Blue Carbon Policy Options Assessment* (Climate Focus, 2011).

Finally, there is also the option for countries to develop national, or sub-national, markets for Blue Carbon ecosystem services, without explicit reference to international regulatory or voluntary markets and the associated standards and methodologies. Independent markets already exist in countries such as Australia, Korea, Mexico, Costa Rica, California in the United States, Ache in Indonesia, Acre in Brazil, and several Chinese provinces. In those countries and states, Blue Carbon ecosystems may be included within the existing policies and mechanisms.

Under all of these scenarios, national or sub-national governments can also support efforts to clarify current constraints or areas of significant uncertainty regarding the development of ecosystem-based management and initiatives, in general, and Blue Carbon initiatives in particular. Such regulatory or policy clarifications might include tenure (for land, carbon, and carbon trading rights), taxation, and other issues. In a related strategy, governments can also offer a variety of incentives to those seeking to promote such initiatives, particularly for the private sector. Such incentives might include preferred access to (and improved terms) for finance, tax holidays or reductions, and accelerated depreciation of investments.

Further information on the status of Blue Carbon policy can be found in the following:

Coastal Blue Carbon and the United Nations Framework Convention on Climate Change: Current Status and Future Directions (Murray *et al.*, 2012)

<http://nicholasinstitute.duke.edu/sites/default/files/publications/coastal-blue-carbon-and-the-unfccc-paper.pdf>

Blue Carbon Policy Framework 2.0 (Herr *et al.*, 2012)

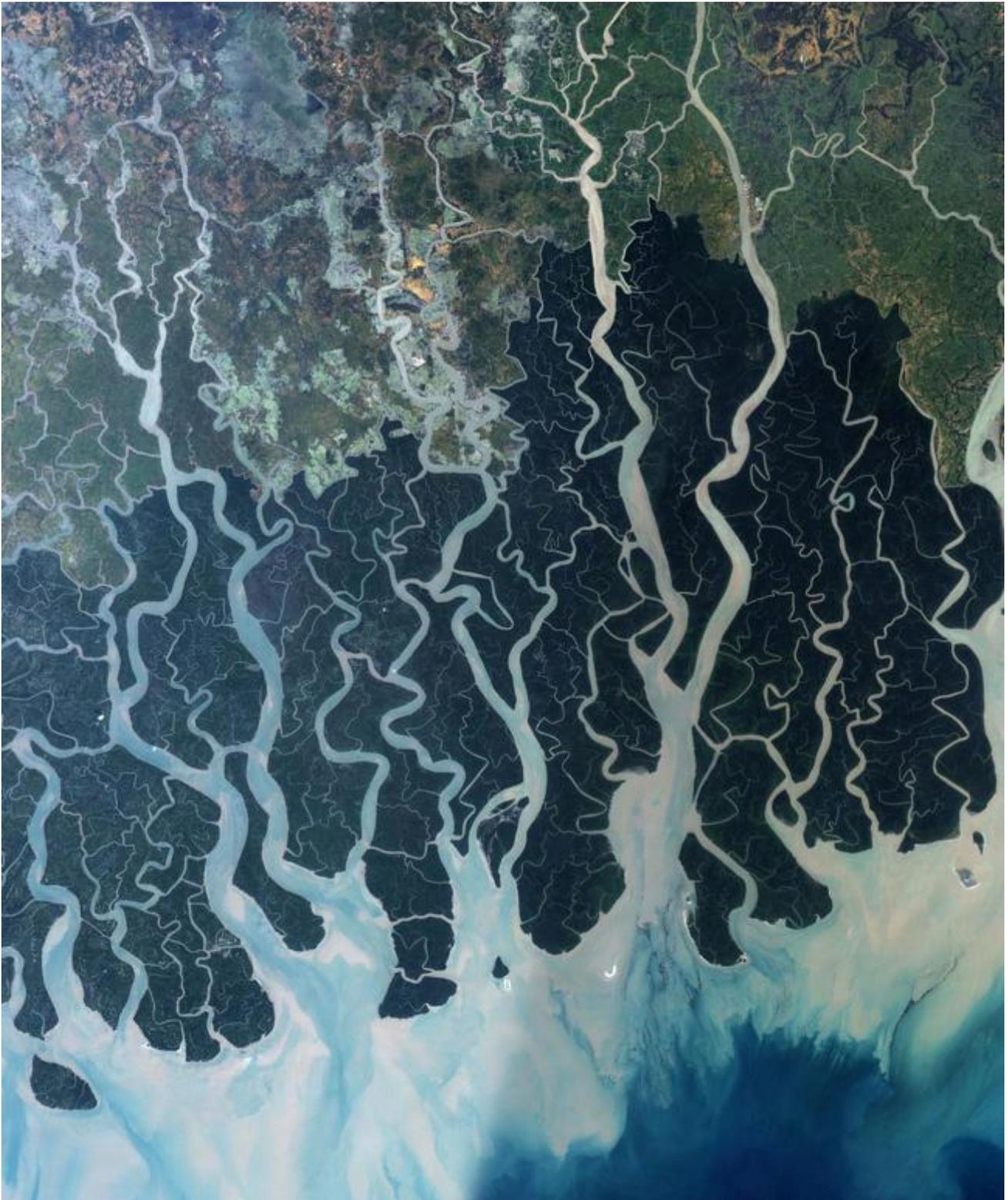
<http://data.iucn.org/dbtw-wpd/edocs/2012-016.pdf>

Blue Carbon Policy Options Assessment (Climate Focus, 2011)

http://www.climatefocus.com/documents/files/_blue_carbon_policy_options_assessment.pdf

Key takeaways:

- Policy settings will vary from project to project with different countries and regions having differing policy capacities.
- Policy development regarding Blue Carbon is still relatively recent, and promoting Blue Carbon activities within Nationally Appropriate Mitigation Actions may be considered productive.
- Mangroves need to be included in the existing national forest definitions and in other REDD+ implementation strategies as appropriate.
- National and sub-national governments can deploy a number of policy and regulatory tools to promote Blue Carbon and other ecosystem-based climate change mitigation strategies.



Stretching across part of south-western Bangladesh and south-eastern India, the Sundarbans is the largest remaining tract of mangrove forest in the world (UNEP, 2005. Image credit NASA).

2 Considerations for Blue Carbon Projects

2.1 Economic and financial considerations

When considering the feasibility of Blue Carbon projects, it is important to distinguish between economic and financial analysis. The **economic feasibility** of Blue Carbon projects concerns the monetary benefits and costs of the project to a given economy, or society as a whole. The **financial feasibility** of a Blue Carbon project concerns the benefits and costs to a given enterprise. In general terms, an economic evaluation of existing Blue Carbon ecosystems estimates the benefits provided by these natural areas, in terms of the avoided emissions of carbon stocks (and other greenhouse gases, notably methane) and the future sequestration that would continue to occur should the ecosystems not be converted to other uses. This analysis can also include the other ecosystem services of these resources, which may be significantly greater than the Blue Carbon benefits.

Generally speaking, projects that value the full range of Blue Carbon ecosystem services are supported by governments and donors with broad socio-economic and environmental concerns. Projects that are more strictly focused on developing carbon credits are developed by investors motivated by positive financial returns and in some cases, a triple bottom line return that includes socio-economic and environmental benefits.

Broader economic analysis is suited primarily to protecting existing Blue Carbon ecosystems from conversion to other activities, whereas the more narrow financial analysis tends to focus on restoration. This difference is due in large part to the fact that international Blue Carbon standards and methodologies are only beginning to include avoided conversion of such ecosystems. In the case of restoration projects the decision about whether to proceed or not is taken by the investors who need to provide the initial capital and human resources, based on their expectations of a financial return.

Financial analysis will need to account for the initial costs of project preparation and compliance with the requirements, in addition to the legal and other fees incurred in formalizing commercial agreements. These agreements typically cost more than U.S. \$100,000 and require several years to be completed. There are also on-going project management and verification costs that need to be taken into account.

The financial analysis used to determine the feasibility of Blue Carbon restoration projects, tend to be based on net present value (NPV) calculations. That is to say, those calculations that subtract projects costs from the estimated benefits of an ecosystem, along with related calculations of the internal rate of return (IRR) and or break-even analysis. Some of the analysis and calculations draw from the experience of REDD and other forest carbon investments via an initial due diligence process.

For most investors, the critical issues they seek to determine are the following:

1. whether the project could meet the eligibility criteria of the carbon standards and methodologies that they will use to obtain credits;

2. the estimated volume of carbon credits that a given project could develop;
3. the timeframe for developing the credits; and
4. the associated costs.

They also tend to estimate the level of risk involved, or the likelihood that the project can be successful. Then they estimate the likely revenue that they can obtain, typically based on a range of future carbon credit prices, given historical market conditions and trends, and the investors' sense of future demand and market dynamics. Such analysis often incorporates various scenarios, typically a "pessimistic", "most likely", and "optimistic" scenario.

If the project is determined to be sufficiently attractive by the investors, they would then move forward with project development activities, committing their financial and human capital. Most investors choose to do this in phases and then assess whether to continue with full implementation based on if the reality they experience as they move forward, and if their assumptions about market conditions and other key variables, comply sufficiently with the projections in the project design. In most cases, if there is significant variance between the projections and the actual experience, the project is modified based on new information and its feasibility reassessed, or, in the worst-case scenario, abandoned.

There are often important considerations of how local communities living in and or adjacent to projects sites should benefit. Interacting with these communities and or those representing their interests is essential to ensure genuine acceptance of what is proposed and the long-term viability of any project. Such interactions also provide the opportunity to begin capacity building for coastal communities: the capacity to participate in the process, frame the project, and implement and manage the project over time. Government approval is also required for private sector and or other independent actors involved in the development of restoration projects, which also tends to add additional uncertainty, time, and costs. These costs are in addition to those needed to meet the requirements of international carbon credit standards. It is worth noting that these processes

"We regard Blue Carbon credits as offering a win-win-win scenario for responsible investors. They represent a scientifically robust route to offset carbon emissions, provide much needed sustainable investment in sensitive, biologically diverse coastal ecosystems, and provide essential development support to the communities that rely on them."

Nigel Winser
Executive Vice President
Earthwatch Institute

and consultations often entail significant extra time and costs for government agencies and project developers.

In very general terms, for Blue Carbon projects doing either conservation or restoration there tend to be economies of scale-involved. Thus, working in larger areas is typically more cost-effective than working in smaller areas. Also, where carbon stocks and sequestration rates are relatively high, and where the protected area establishment, management and opportunity costs are relatively low, the projects are likely to be more economically and financially feasible. For mangrove reforestation and afforestation projects, supporting practices that assist natural regeneration or expansion of these areas, typically by focusing on hydrological management issues, tend to be more

cost-effective and economically and financially feasible than plantation style reforestation techniques.

In many cases the economic value of the other ecosystem services will significantly exceed the value of Blue Carbon, especially given relatively low current international demand and prices for such carbon credits. However such values typically do not translate into the willingness of buyers to pay for such benefits, though there are increasing efforts to account for such values within national accounting systems².

Under most circumstances and conditions, for those entities contemplating the development of Blue Carbon projects, as with other carbon credit projects, it is important to assemble an expert team. Engaging knowledgeable experts, the relevant carbon standard authorities, and potential donors/buyers of future credits will help determine the eligibility and prospects. It will also help develop estimates of the associated benefits and costs, prior to making final decisions to embark upon project implementation.

For example, in the case of the Abu Dhabi Blue Carbon Demonstration Project, such preliminary analysis has indicated that the total value of the suite of Blue Carbon ecosystem services associated with increased conservation of such areas would have a strongly positive NPV, whereas the development of Blue Carbon credits associated with mangrove afforestation and reforestation alone, without accounting for the other ecosystem services, would have negative NPVs. While this analysis is based on a number of assumptions, estimates and extrapolations, and so needs to be further refined before any definitive conclusions can be made, it has been instructive in helping to determine which approaches to explore to ensure the generation of Blue Carbon ecosystem services in the future.

Further information on economic considerations for Blue Carbon can be found in the following:

Green Payments for Blue Carbon: Economic Incentives for Protecting Threatened Coastal Habitats (Murray et al., 2011)

<http://nicholasinstitute.duke.edu/sites/default/files/publications/blue-carbon-report-paper.pdf>

Key takeaways:

- Economic analysis of a Blue Carbon project values the full range of ecosystem services provided by a system and is done in a broad, socio-economic context.
- Financial analysis is likely to move a project forward based on the expected revenue from carbon credit sales.
- Economic and or financial analysis may illustrate that other ecosystem services provide more value than the carbon itself.

²For more information refer to the Wealth Accounting and Valuation of Ecosystem Services (WAVES) Partnership of the World Bank (www.wavespartnership.org).

- Engagement of the right experts and community stakeholders is important for making a determination of the potential for project success and to build capacity around Blue Carbon projects

2.2 Institutional Considerations

For the implementation of Blue Carbon projects to be sustained and successful, it is important that there first be an enabling environment for adequate institutional coordination across appropriate governmental agencies and levels. However, achieving such an environment may be hampered by institutional barriers common to many countries, as summarized below:

Legal frameworks for coastal management are typically incomplete and suffer from critical gaps: there may be several issues that are missing in a country's current legal framework to ensure the holistic and effective protection of Blue Carbon ecosystems (especially intertidal ecosystems). Laws, regulations and mandates may be inadequate or contradictory, resulting in a lack of clarity about the roles and responsibilities of individual agencies. Furthermore, many jurisdictions lack a comprehensive institutional framework for coastal protection and management that addresses the risks of climate change and marine pollution.

Agencies responsible for coastal management often lack the technical capacity or necessary knowledge to implement Blue Carbon: Capacity building has to come first to overcome the gaps in knowledge and expertise. Such barriers can include inadequate information exchange among regional research centres and local governance councils, as well as a lack of national technical capacity to plan, implement, or monitor adaptation measures such as Blue Carbon projects.

There are often no institutionalized mechanisms for managing potential conflicts among multiples users of coastal resources: There may also be a lack of awareness and understanding of coastal ecosystem benefits that affects community awareness of sustainable coastal management needs. In many settings there is a lack of formal way to include civil society perspectives on coastal and marine protection activities, which necessitates creating a method to build community awareness and civil capacity to support the projects over time.

Overcoming the institutional barriers requires attention to regulatory, coordination, jurisdictional and technical capacity factors:

Regulatory factors provide the basis for institutional action. It is likely that most countries have regulations in place specifically requiring that impacts on ecosystem services be considered during activities that affect the coast such as development (e.g., environmental impact statements). Such regulations may offer readily achievable targets for the incorporation of Blue Carbon values into policy and management. However, it is unlikely that many countries, if any, require an assessment of the economic value of ecosystem services in estimates of economic impact of projects that disrupt the delivery of those ecosystem services. Enacting a new regulatory requirement that calls for the explicit assessment of Blue Carbon ecosystems - as well as an assessment of the economic value of the environmental services they render - could profoundly influence actions based on existing pieces of legislation governing the protection and management of coastal habitats.

Coordination factors define roles and responsibilities across institutions. Typically the responsibility for Blue Carbon projects would lie within Environment Ministries, Protection Agencies, and corresponding sector ministries, such as Forestry and Fisheries Departments or Authorities. For Blue Carbon projects to succeed it would be generally advisable to develop projects in those countries where Agencies and Ministries have a successful implementation track record of environmental projects, especially those focusing on afforestation, reforestation and REDD/REDD+. Another activity central to effective institutional coordination is ensuring wide stakeholder participation in the drafting and project planning phase for Blue Carbon projects and ensuring that stakeholder lists are based on the people who are doing these activities

Jurisdictional factors affect the allocation of institutional authority relative to provincial and or national boundaries. The institutional feasibility of Blue Carbon projects can be enhanced with a pre-eminent role for the national government in the establishment of jurisdictional boundaries regarding policymaking, master plan development, monitoring, and enforcement activities that affect Blue Carbon projects. Provincial or regional policy, though clearly important, can vary significantly from area to area. National policy, on the other hand, can be applied in a relatively standardised way throughout a country and address jurisdictions directly. As a starting point, project developers need to assess the jurisdictional boundaries and authorities related to Blue Carbon resources.

Technical capacity factors reflect the scientific expertise within institutions to carry out any needed assessments. Blue carbon is a relatively new concept and not surprisingly, there is typically limited national technical capacity for estimating and valuing Blue Carbon ecosystems. Network building between developers and national institutions is one approach to build such capacity. That is, given the complexities involved and the early stage of Blue Carbon development, it would be generally advisable to engage with seasoned forest carbon project developers and or international NGOs that demonstrate a successful track record in bringing projects to completion, under either the regulatory or voluntary carbon markets.

Key takeaways:

- It is crucial to continually engage with institutional stakeholders throughout the entire project planning and implementation process.
- Project developers should convey to stakeholders the mandate for Blue Carbon activities and identify the appropriate authoritative bodies.
- Project developers should have an understanding of potential conflicts of interest between government agencies or others, along with a plan for addressing such issues.
- A good preliminary target for recognizing the value of Blue Carbon is to identify areas in existing policies and management where Blue Carbon may be easily incorporated.



Blue Carbon research in Mahajamba Bay, Madagascar (image credit and © Garth Cripps, Blue Ventures).

3 Blue Carbon Projects

Though advancing globally, Blue Carbon is still very much developing, and not all Blue Carbon activities will be uniform. In fact, a rigid plan or template for Blue Carbon projects would likely be counterproductive as a flexible approach to project development better suits the varying conditions and objectives of potential projects worldwide. This section discusses the potential phases of a Blue Carbon approach, potential elements of Blue Carbon projects, and what types of projects are being advanced worldwide, based on the experiences of existing and planned Blue Carbon projects and other sources.

3.1 Phases of Blue Carbon Project Development

The application of Blue Carbon can be generally broken down into four project phases: scoping, planning, demonstration, and implementation, illustrated in the following bullet points and in Figure 3. **We recognize that the following descriptions are generalized and that some elements or activities may occur concurrently depending on a project's objectives.** The description of each phase centres on key aspects in project development. This guide principally focuses on the scoping and demonstration phases of Blue Carbon.

- *Scoping phase:* This phase involves establishing a foundation for Blue Carbon projects, including identifying stakeholders (Figure 4), targeted geographic area, habitat type, key issues, and developing overarching project goals.
- *Planning phase:* This phase addresses how a plan for a Blue Carbon demonstration project is designed. During this phase measurable objectives and clear overarching goals are set, potential project partners and funders are identified, and scientific methodologies

Phases of Blue Carbon

Scoping - Establishing a Foundation for Blue Carbon

- Develop a common understanding of Blue Carbon
- Build interest, expand participation, and create settings for sectors and stakeholders to come together
- Identify target geographic areas of Blue Carbon ecosystems and key concerns/drivers of loss and degradation
- Take stock of existing management practices and scientific capacity
- Clearly illustrate the need for and scope of a potential project

Potential deliverables: Workshop, Scoping Study

Planning - Plan the Process

- Identify measurable objectives and set clear overarching goals
- Identify potential project partners
- Identify potential sources of funding
- Choose science methodologies for Blue Carbon assessment

Potential deliverables: Project Proposal

Demonstration - Testing Blue Carbon

- Implement Blue Carbon methodologies including in depth ecosystem assessments and geographic analysis
- Measure, evaluate, and adapt
- Evaluate governance options and legal frameworks to support multi-sectoral management
- Prioritize threats, evaluate management options, and examine trade-offs
- Continue to communicate and educate (policy and outreach)

Potential deliverables: Assessment reports, PDD including governance options

Implementation - Applying Blue Carbon

- Secure accreditation
 - Secure sustainable financing for Blue Carbon implementation over time (via. carbon market, multi PES approach and/or other mechanism)
 - Monitor, evaluate, and adapt
- Potential deliverables:* secure and sustainable funding for the conservation and/or restoration of Blue Carbon habitats

Figure 3 Phases of a Blue Carbon approach (adapted from UNEP, 2011).

for Blue Carbon assessment are defined.

- *Demonstration phase*: This phase involves the exploration of and demonstration of the valuation of Blue Carbon and the identifying of options for this value to be incorporated into improved ecosystem policy and management. Here, it is also decided how the value of Blue Carbon may be employed - through carbon finance, conservation agreements, recognition in policy and management, or other mechanisms. Good data and information are critically important for the demonstration phase - with assessments of Blue Carbon ecosystems, evaluations of governance options, and more.
- *Implementation phase*: This phase addresses how Blue Carbon can be implemented and results in improved coastal ecosystem management, as well as how it can be adjusted over time to stay effective and sustainable over the long-term.

3.2 Conducting a Blue Carbon Scoping Study

Undertaking a scoping study (or feasibility assessment) is a first step in understanding what Blue Carbon activities are best suited to a particular site or region. A scoping study provides an overview of a Blue Carbon ecosystem, stimulates and or gauges the interest of relevant stakeholders, and uses a consultative process to set overarching goals for a Blue Carbon project. Priorities of a Blue Carbon scoping study may include:

- Identifying target geographic areas of Blue Carbon ecosystems and the drivers of loss or degradation;
- Understanding and building interest, expanding participation, and creating settings for sectors and stakeholders to converge;
- Establishing a common understanding of Blue Carbon and options for a project;
- Taking stock of existing relevant management practices and policies, scientific capacity and data resources; and
- Identifying potential ecosystem services whose value could be leveraged to support the project's activities and goals (e.g., shoreline protections, safeguarding commercial fishing stocks (see Sections 4 and 5)) and understanding potential social and environmental risks.

Appendix 1 provides an extensive list of suggested questions for use during a scoping study that will help guide the development of a future Blue Carbon demonstration project. One deliverable

Potential Blue Carbon Project Stakeholders

Resource users

- Local coastal communities living around blue forests that depend on them for livelihoods and food security

Private sector

- *Tourism / recreation* – coastal tourism and ecotourism, hotels, cruise ship industry that gain revenue from healthy blue forests ecosystems
- *Fisheries / food security* – fisheries organizations and food security stakeholders that rely on blue forests ecosystem health
- *Flood / storm protection* – insurance agencies, disaster relief agencies
- *Carbon market* - companies and bodies that buy carbon credits or pay for ecosystem services or facilitate such markets
- *Development / investment* - bodies involved in other aspects of coastal development that may impact blue forests ecosystems

Science and academia

- Local and national universities and students
- Regional and international scientists working on other Blue Carbon projects and efforts

Policy, management and decision-making

- *Local* - community groups, local protected area authority
- *National* – environmental management and climate change authorities
- *International* – international commitments (RAMSAR, UNFCCC, CBD)

Figure 4 Potential Blue Carbon project stakeholders.

of a scoping study may be an exploratory report that provides the basis for expansion to a project-level demonstration.

Further information on Blue Carbon scoping studies, feasibility assessments and project planning can be found in the following:

The Management of Coastal Carbon Sinks in Vanuatu: Realising the Potential: Scoping and Feasibility Study (Laffoley, 2013)

<http://thecommonwealth.org/sites/default/files/project/documents/The%20Management%20of%20Coastal%20Carbon%20Sinks%20in%20Vanuatu%20-%20Realising%20the%20Potential.pdf>

Mangrove Ecosystem Services & Payments for Blue Carbon in Solomon Islands (Albert et al., 2012)

http://www.worldfishcenter.org/resource_centre/WF_3052.pdf

Blue Carbon - First Level Exploration of Blue Carbon in the Arabian Peninsula, with Special Focus on the UAE and Abu Dhabi: A Rapid Feasibility Assessment (Lutz, 2011)

www.grida.no/files/publications/bluecarbonabudhabi_lowres-rb.pdf

Mikoko Pamoja Plan Vivo Project Idea Note (Plan Vivo, 2010)

www.planvivo.org/wp-content/uploads/gazi_pin_PlanVivo_Kenya.pdf

Key takeaways:

- A scoping study presents an opportunity to critically assess a project's potential, and to identify key local and national stakeholders, and potential project partners.
- Potential deliverables for a scoping include initial stakeholder workshops and a scoping study report (including project idea notes).
- It is encouraged that stakeholders are engaged early and continuously through the project.



Blue Carbon in the Arabian Peninsula Feasibility Assessment

During the summer and fall of 2011, AGEDI conducted a feasibility assessment for Blue Carbon in the Arabian Peninsula, with the goal of undertaking a first-order exploration of what a Blue Carbon approach could look like locally, nationally and regionally, and to start a discussion that could be continued at a focused session at the Eye on the Earth Summit in December 2011. Over 40 meetings were held with local, national, and regional authorities and with organizations from three countries in the Arabian Peninsula. The project identified preliminary science and policy needs, project partners and stakeholders, and represented a significant milestone for Blue Carbon. The project produced a report titled *Blue Carbon - First Level Exploration of Natural Coastal Carbon in the Arabian Peninsula* (Lutz, 2011) and successfully laid the groundwork for the Abu Dhabi Blue Carbon Demonstration Project.



Artisanal fishing on a seagrass meadow at low tide in Bali, Indonesia (Image credit Steven J Lutz, GRID-Arendal).

3.3 Elements of Existing Demonstration Projects

A Blue Carbon demonstration project essentially involves the testing of methodologies and approaches for valuing Blue Carbon at a specific project site and exploring and providing mechanisms for improving ecosystem management based on this value. A demonstration project can examine suitability for the carbon market and anticipated greenhouse gas benefits, in addition to other technical, financial, and legal considerations. Elements of existing Blue Carbon projects presented in this section are derived primarily from the Abu Dhabi Blue Carbon Demonstration Project (Case Study 8.1), the project preparation grant (PPG) phase of the GEF Blue Forests Project (Case Study 8.6) and the Plan Vivo certified Mikoko Pamoja Project (Case Study 8.2). Input from the other case studies presented in Section 8 and projects has also been considered.

Blue Carbon demonstrations are expected to vary in scope and size. The case studies we draw on for the elements presented here range from the relatively small scale (i.e., the mangrove carbon exploration of an area of just over 100 hectares in Gazi Bay, Kenya (Case Study 8.2)) to the relatively large scale (i.e., the exploration of carbon, the valuation of ecosystem services and other project components for mangroves, seagrass and saltwater marsh ecosystems in Abu Dhabi (Case Study 8.1)). It is important to note that these approaches are not mutually exclusive.

The following proposed Blue Carbon demonstration project elements illustrate potential common elements. The project elements are arranged under two central themes:

1. **Improving understanding**, which includes activities focused on the application of methodologies and approaches to better understand the value of Blue Carbon, such as the following elements:
 - *Carbon Assessment*
 - *Geographic Analysis and Ground Truthing*
 - *Ecosystem Services Assessment*
 - *Policy and Management Assessment*
 - *Communication and Outreach*
 - *Blue Carbon Viability Assessment*
 - *Project Management and Coordination*
2. **Improving capacity and ecosystem management**, which includes activities designed to utilize the value of Blue Carbon to improve coastal ecosystem management along with enhancing capacity where needed to sustain this approach, such as the following elements:
 - *Capacity Building and Knowledge Transfer*
 - *Policy and Management Engagement*

It is important to note that project elements are expected to differ according to each national setting, need and project context for potential Blue Carbon demonstration projects

Carbon Assessment

The Carbon Assessment provides the essential data and analysis for quantifying the values of Blue Carbon storage and sequestration and storage at a project site. This is accomplished through the analysis of satellite images, the gathering of samples and carbon stock measurements through field research and laboratory analysis. Activities for the carbon assessment element can include the following:

- Establishing the location of the project's targeted field surveys (sample plots) based on geographic analysis;
- Estimating the carbon stocks of the project site's standing Blue Carbon through the collation of existing data and targeted field surveys. The targeted field surveys apply methodologies for carbon assessment (see following text box) and will also facilitate the ground truthing of the satellite imagery analysis and include the collection and analysis of Blue Carbon biomass and sediment samples or cores; and
- The production of a carbon assessment report.

Methodologies for Blue Carbon assessment

Coastal and marine ecosystems have been explored in a carbon context for years, with seminal research on coastal productivity and the fate of mangrove organic matter published in the late 1960's and early 1970's (e.g., Odum 1968, Odum and Heald 1972). Over time many researchers have developed their own methodologies for coastal and marine carbon assessment, such as the initiatives illustrated in Figure 5 and described in the case studies of Section 8. It is only recently that methodologies and projects have been focussed on potential carbon finance. In such a context, "methodologies, also called protocols, are approved by standards and provide specific criteria and procedures for projects. Projects must meet the requirements in a methodology in order to receive carbon credit" (Emmett-Mattox and Crooks, 2013).

The current status of Blue Carbon methodologies includes the following (Emmett-Mattox and Crooks, 2013; Crooks, 2014):

- *American Carbon Registry*, "Restoration of Degraded Deltaic Wetlands of the Mississippi Delta." Status - approved;
- *Verified Carbon Standard*, "Methodology for Wetland Creation." Status - in validation;
- *Verified Carbon Standard*, "Accounting Methods to Determine the Greenhouse Gas Benefits of Tidal Wetland Restoration." Status - draft in preparation;
- *Plan Vivo*, "Mikoiko Pamoja," a community based mangrove carbon project in Kenya (Case Study 8.2). Status - unknown (the project is reportedly certified and awaiting first payment);
- *International Blue Carbon Initiative*, "Blue Carbon methodology" - in development; and
- *Abu Dhabi Blue Carbon Demonstration Project*, "Carbon Baseline Assessment Methodology Report" - pending (Case Study 8.1).

Geographic Analysis and Ground Truthing

The project's Geographic Analysis and Ground Truthing element covers the critical spatial analysis required for the assessment and management of potential Blue Carbon mitigation projects -

essentially the understanding of a project sites' total natural carbon stock and the resources and ability to effectively manage, verify and monitor this resource. This element should include the production of spatial dataset for the extent of a Blue Carbon ecosystem (e.g. maps of carbon stock), the development of a central spatial database and online tools (for scientists and managers) and the validation of these data sets through workshops and ground-truthing. Key tasks covered in the Geographic Analysis and Ground Truthing element could include the following:

- Establish a spatial dataset for Blue Carbon ecosystem extent, using satellite data and imagery, including aerial photography if available. Such imagery may already exist with local partners. Steps could include the following:
 1. Identify the ecosystem type (e.g., mangrove) and sub-types (e.g., ecologically distinct types of mangrove forest with equally distinct carbon stocks) of interest.
 2. Inventory all existing spatial data-sets covering the habitat of interest to determine whether existing maps are contemporary, cover the entire area of interest, provide the level of detail in terms of habitat sub-types, and are accurate (ground-truth/expert consultation).
 3. If existing maps suffice, these should be used to establish field plots and or collect samples; if existing maps are not good enough, new map(s) must be derived from remotely sensed data and subsequently ground truthed to assess accuracy prior to establishing plots/collecting samples.
 4. Once plots have been established and or field data have been collected, then a central data-base can be created for storage and upload.
- Understand historical ecosystem coverage and uses and impacts, and consequently the projection of future uses and potential impacts; and

Validate and ground-truth the spatial dataset to ensure accuracy and precision, which could be achieved through the development of online validation tools and the holding of local expert workshops, field-based measurements coordinated with the carbon assessment, and the development of a central database for storage and upload of geographic data.

Ecosystem Services Assessment

An ecosystem services assessment is an optional element that explores the linkages between human well-being and ecosystem services in addressing environmental and sustainability issues. This is an optional element for Blue Carbon projects, for those interested in potentially bundling or staking the value of carbon sequestration with other Blue Carbon ecosystem services in promoting improved ecosystem management. Both the Abu Dhabi Blue Carbon Demonstration Project (Case Study 8.1) and the Global Environment (GEF) funded interventions of the Blue Forests Project (Case Study 8.6) include ecosystem services elements. A combined Blue Carbon and ecosystem services approach is described in Section 4. Tasks for an ecosystem services assessment can include the following:

- Assessing existing information regarding Blue Carbon ecosystem services in a national or project site context and identifying information gaps;
- Filling in identified information gaps through early and continuous stakeholder and community-level socioeconomic engagement, including workshops, surveys and questionnaires; and
- The production of an ecosystem services assessment report.

Further information on a combined Blue Carbon and ecosystem services approach can be found in Section 4.



Seagrass habitat assessment and ground truthing off Marawah Island, Abu Dhabi (image credit AGEDI/Steve Crooks).

Policy and Management Assessment

The policy and management assessment element considers Blue Carbon in a local and national coastal ecosystem management context (e.g., coastal and marine protected areas and environmental rules and national climate change mitigation policies). This element aims to identify how Blue Carbon can be incorporated into local and/or national level policy and management and result in improved ecosystem management. Tasks for this element can include the following:

- Stakeholder engagement to assess existing rules and policies and identify any contradictions or gaps in policy that might serve as a barrier to incorporation of Blue Carbon;
- Policy analysis and the production of a report identifying policy and management steps forward towards improved ecosystem management.

Communication and Outreach

Successful projects require a communication and outreach strategy that focuses on educating key constituencies, stakeholders, and future project designers. For an emerging concept such as Blue

Carbon, such strategies are particularly important because the concepts are new and so are the projects themselves.

The Communication and Outreach element ensures that policy makers, coastal managers and other stakeholders at the project site and nationally can be kept up to date and made fully aware of the project, its progress, and the value of Blue Carbon. Tasks can include the following:

- A Communication and Outreach strategy developed at the beginning of the project that identifies the sequence of information sharing from the planning through the implementation and monitoring phases, identifies spokespeople, and engages stakeholders and the general public;
- Assessment of the need for, and development of, different types of informational materials such as brochures, publications, press kits, and messaging to ensure regular, consistent communication with local and regional stakeholders, decision makers, experts, and community leaders;
- Development of presentations for relevant workshops, conferences, and other meetings to engage local, national and international stakeholders and potential proponents; and
- Creation and maintenance of a project website to support the Communication and Outreach strategy, help educate stakeholders and potential allies about Blue Carbon and the project in particular, and provide regular updates as to progress and outcomes over time.

Information can be derived from formal science (such as carbon assessments) and from local and traditional knowledge as well. It is important that information flows back and forth from the stakeholders and any partners responsible for inter connected project elements – hence the need for continual measurement, assessment, and adaptation.

Blue Carbon Viability Assessment

Subsequent to the results of the Carbon Assessment, Policy and Management Assessment and other project activities, it is essential to conduct an initial assessment of a project's potential for the value of Blue Carbon to be used and result in improved ecosystem management. The Blue Carbon Viability Assessment element represents a key decision point. This is the opportunity to take an open-minded, critical, and comprehensive look at the feasibility of a Blue Carbon project. It has to be clear during the exercise that a positive outcome cannot be assumed.

In order to understand the feasibility for developing a Blue Carbon project, the outputs from the scientific teams, particularly the carbon accounting and data, need to be combined with other sectoral, legal, technical, market, and social analyses and presented in a format and structure that can be certified (such as a Project Design Document (PDD) or documents necessary for other mechanisms that use the value of Blue Carbon). Activities for the Blue Carbon Viability Assessment can include the following:

- Advising the scientific teams in their carbon assessments, with regard to carbon accounting and data gathered;
- Assessing and analysing the sectoral components and framework of a potential mechanism for utilizing Blue Carbon values, including the legal, technical, market, and social aspects; and

Understanding pathways and mechanisms that utilise the value of Blue Carbon to improve ecosystem management (e.g., carbon finance PDD or Blue Carbon Viability Assessment Report) and producing recommendations for steps forward.

Project Management and Coordination

Project Management and Coordination covers the management, coordination and reporting elements of the project. Its focus is to manage all of the various project elements and activities and to ensure that they are carried out effectively and successfully. As Blue Carbon projects can include multidisciplinary teams and exerts with a wide range in backgrounds and experience, this element will involve working across groups, aligning internal team members and partners, and managing external stakeholders. Primary activities for Project Management and Coordination can include:

- Coordination of all project activities and elements according to a master schedule, using a flexible and adaptive management process;
- Management of the project partners, including contract administration, authorisation and memorandums of understanding;
- Using a flexible and adaptive management process; and
- Acting as the responsible party for the on-time production of project deliverables and project reporting.

Improving capacity and ecosystem management

Capacity Building and Knowledge Transfer

Sustainable management of the marine environment relies on sound scientific data and information. Blue Carbon projects depend on access to, and availability of, credible and reliable environmental data, knowledge, and information. Also essential is the integration, translation and communication of this data and information into policies, the carbon and other markets, and decision making at the national and international level. Capacity building in carbon assessment and spatial analysis is essential for effective verification, accounting and monitoring of Blue Carbon. This is especially true if the process is to be maintained after the demonstration project.

A Blue Carbon project can provide many opportunities for partners and stakeholders to gain understanding in Blue Carbon (illustrated in Section 6). Activities for the Capacity Building and Knowledge Transfer element can include the following:

- Holding training and capacity building workshops that teach local stakeholders and enhance national science capacity in the measurement and accounting of carbon in Blue Carbon ecosystems;
- Providing training in the use of geographic tools to support continued assessment and monitoring efforts;
- Developing recruitment and training programs to deepen the capacity for monitoring and related activities; and

- Using networks with other Blue Carbon efforts (e.g., South to South exchanges), in which both developing countries share knowledge, experience, technical prowess, appropriate technologies, financial and in-kind contributions, etc. and developed countries serve to facilitate and foster.

Policy and Management Engagement

The policy and management engagement element primarily builds on the Policy and Management Assessment and the Blue Carbon Viability Assessment and explores ways to bring the value of Blue Carbon more clearly to the attention of policy makers and environmental managers. This element aims for the value of Blue Carbon to be incorporated into policy and management at the national and/or local levels. Tasks for this element can include the following:

- The presentation of options for translating the value of Blue Carbon into improved ecosystem management with key local and national policy stakeholders.



Blue Carbon ecosystems are vitally important for coastal and marine biodiversity such as this endangered Florida manatee swimming over a seagrass meadow off Key Biscayne, Florida (Image credit Steven J Lutz, Blue Climate Solutions).

3.4 Existing Blue Carbon Projects Worldwide

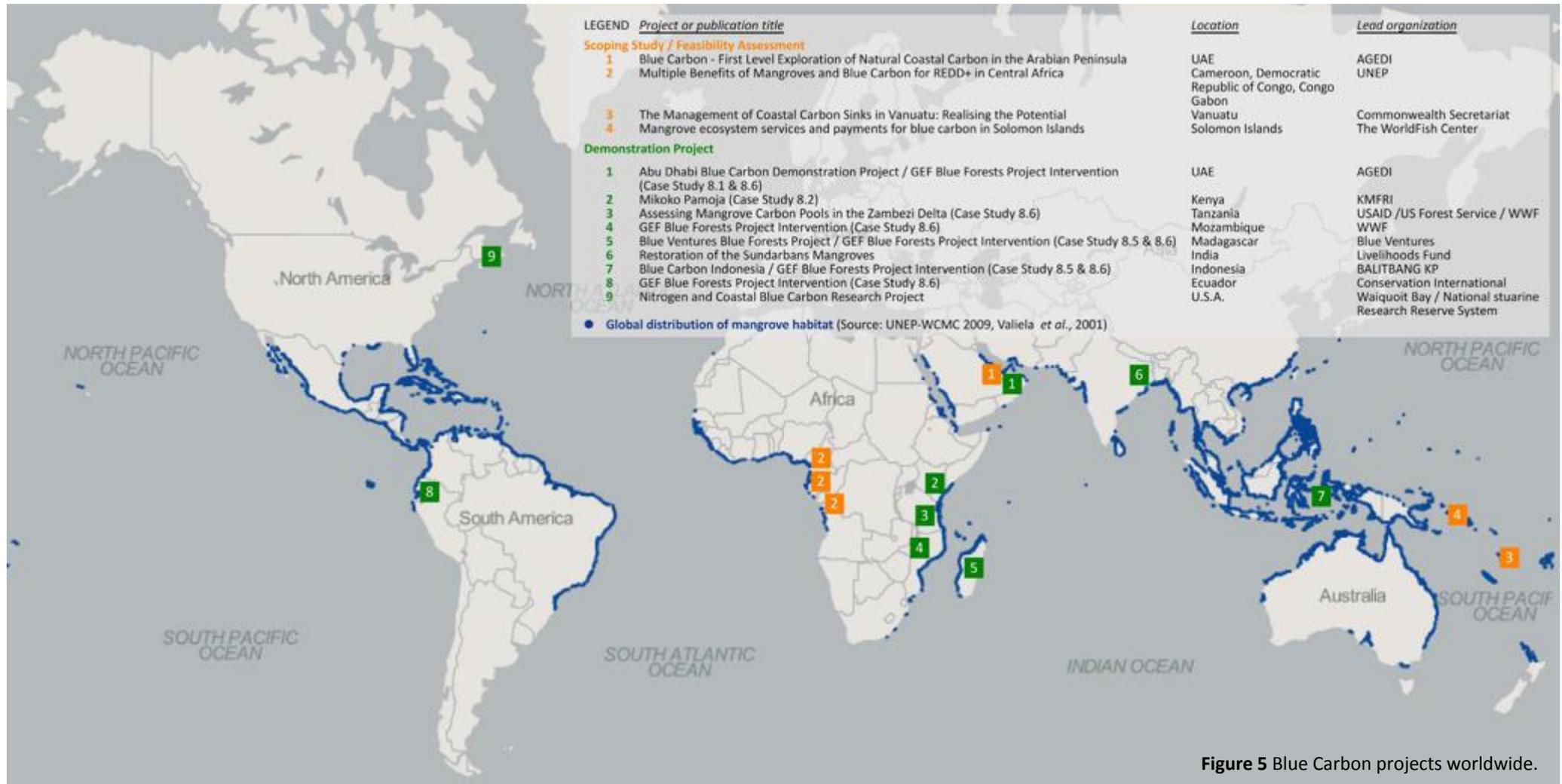


Figure 5 Blue Carbon projects worldwide.

The Blue Carbon world is rapidly growing. Over the past several years, a variety of efforts and initiatives, from feasibility assessments to full-scale demonstration projects, have taken shape, and continue to do so. The global map of Blue Carbon illustrated here in Figure 5 is based on information presented in the UNEP and GRID-Arendal managed Blue Carbon Portal (Blue Carbon Portal, 2013), Bredbenner, 2012, Albert *et al.*, 2012, Laffoley, 2013, Ajonina *et al.*, in press, and provides an overview of these activities. It is however, a snapshot of information and not intended to be a comprehensive portrayal.

4 Blue Carbon and the Valuation of Other Ecosystem Services

Blue Carbon ecosystems provide a wide range of important ecosystem services to many coastal and island states. It is hoped that these services prove to be sufficiently valuable to support better governance, based on the premise that human communities generally only take care of that which we value. The recognition of multiple ecosystem values may provide added momentum to sustainable policies in a combined Blue Carbon and ecosystem services approach.

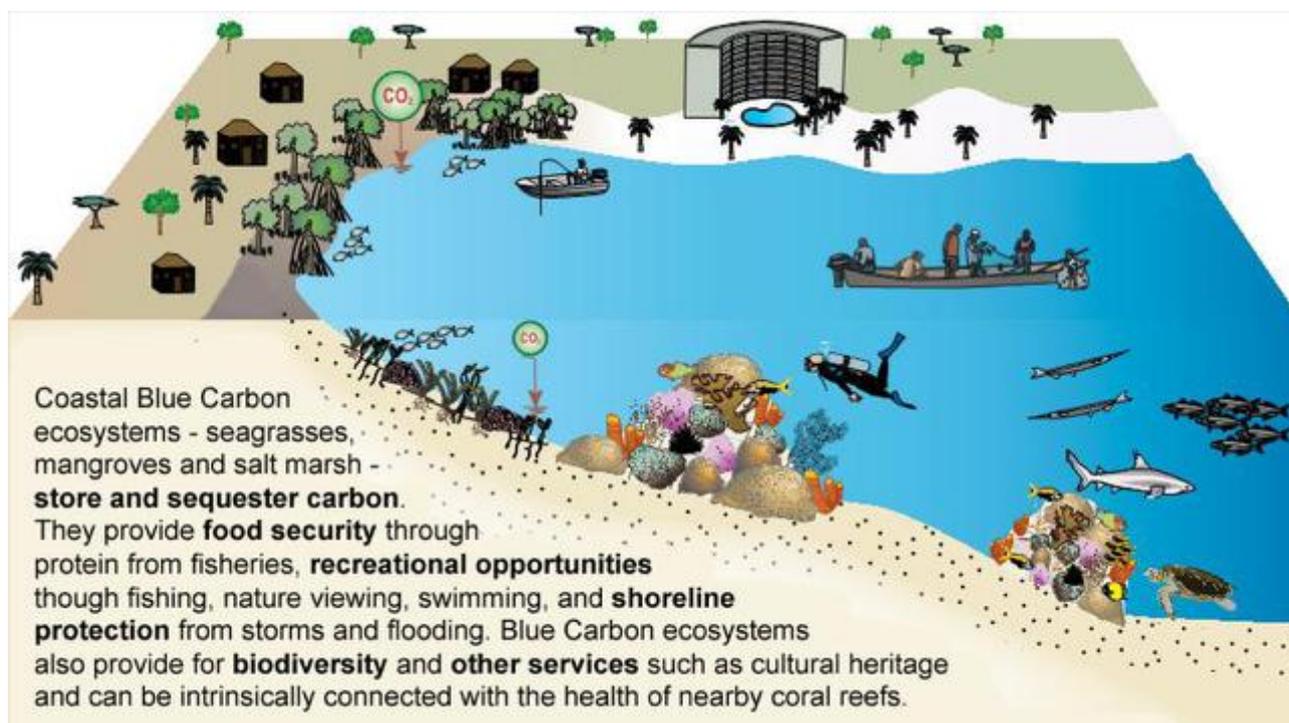


Figure 6 Ecosystem services provided by coastal Blue Carbon habitats (adapted from Samonte *et al.*, 2010).

Ecosystem Services as Blue Carbon Co-Benefits

Coastal ecosystems that generate Blue Carbon usually provide other valuable ecosystem services. These services may be **provisioning services** that generate goods, such as fisheries resources, energy, materials, areas for recreation or tourism, etc.; **supporting and regulating services** that maintain ecosystems and support life on earth; or **cultural and spiritual services** that contribute significantly to human well-being (Figure 6). Mangroves, saltwater marshes, seagrasses, and other coastal and marine ecosystems are naturally productive, and are considered valuable in regards to this production, but they are also vitally important in supporting a broader array of organisms on land, in freshwater, and at sea. They not only fix and store carbon, but they also stabilise shorelines, protect property and life from catastrophic storms, maintain water quality by filtering pollutants, play a role in disease regulation, support fisheries and biodiversity more generally, and bolster human spirit and enterprise. Collectively these ecosystem services support human communities and the natural world as a whole. Yet many such functions are difficult to attach economic value to -- thus these habitats are generally under-valued.



Seagrass beds provide critical habitat for many important commercial and recreational fisheries such as the Florida stone crab, pictured here in Biscayne Bay, Florida (Image credit Steven J Lutz, GRID-Arendal).

The many ecosystem functions and services that coastal and marine ecosystems provide are tightly interlinked. For example, by conserving mangroves or other coastal ecosystems to maximise Blue Carbon, broader biodiversity is protected; fish habitats remain intact, leading to increased fisheries production; the natural ^{SEP} waste processing function of wetlands is maintained, leading to better water quality; coastal zones are ^{SEP} better buffered from the potential damaging impacts ^{SEP} of storms; and opportunities for improving coastally-dependent livelihoods can be realized. These ecosystem services are thus co-benefits to Blue Carbon and in turn, Blue Carbon is a co-benefit of these other services.

A Combined Blue Carbon and Ecosystem Services Approach

A combined Blue Carbon and ecosystem services approach may be necessary to secure the sustainable management of Blue Carbon ecosystems. Blue Carbon by itself may not generate enough funds to support the sustainable financing of conservation efforts, due to potentially high opportunity costs associated with coastal land, the high transaction costs associated with these types of projects (development, verification, and monitoring costs may outweigh carbon revenue), and a relatively low current price of carbon on the carbon market. A bundled or combined approach with payments for other ecosystem services may be necessary to ensure long-term sustainable financing and management.

Additionally, as many coastal communities are connected to and depend on the services that Blue Carbon ecosystems provide, pursuing a Blue Carbon agenda without considering the full connection of coastal communities to their ecosystems may cause economic hardship and generate political ill-will. Conversely, if ecosystem services are considered and valued, Blue Carbon projects could gain political support and enhance local economies.



Mangroves provide many recreational opportunities such as this mangrove boat tour on Lembongan Island, Indonesia (Image credit Steven J Lutz, GRID-Arendal).

Assessing and Valuing Ecosystem Services

Assessing other services provided alongside carbon sequestration entails understanding the general nature of the mosaic of habitats and how they are inter-linked, assessing their environmental condition to gauge their capacity for ecosystem services generation, and understanding the way these services are valued and perceived in the local context.

Ideally an assessment of co-benefits should be supported by targeted ecological and economic studies. However, in many parts of the world, such studies are absent. In these cases, benefits transfer is justified. A process through which basic assessment of ecosystem coverage and condition is tied to economic and social studies on ecosystem services value taken from other locations. However, assumptions in doing such benefits-transfer must be carefully appraised.

Once additional ecosystem services beyond Blue Carbon are identified and quantified, some assessment of their economic value can be made. When data or time limitations prevent such a systematic approach, proxy values of Blue Carbon co-benefits being generated from Blue Carbon habitats may be used to develop a Blue Carbon scheme. Such proxy values can be derived from

studies in other locations where standardized protocols for assessing ecosystem services generation by evaluating condition have been performed, and where willingness to pay or contingency valuation gives an indication of the value of services. It must be noted, however, that valuation is very context-specific: therefore, the underlying assumptions about benefits-transfer must be explicitly stated.

Further information on Blue Carbon and the valuation of other ecosystem services can be found in the following:

Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean (Waite et al., 2014)

<http://www.wri.org/coastal-capital>

Beyond carbon: Conceptualizing payments for ecosystem services in blue forests on carbon and other marine and coastal ecosystem services (Lau, 2012)

http://www.forest-trends.org/documents/files/doc_3397.pdf

Marine and coastal ecosystem services: Valuation methods and their practical application (UNEP-WCMC, 2011)

http://www.unep-wcmc.org/marine-and-coastal-ecosystem-services-valuation-methods-and-their-practical-application_663.html

Payments for Ecosystem Services: Getting Started in Marine and Coastal Ecosystems: A Primer (Forest Trends and The Katoomba Group, 2010)

http://www.forest-trends.org/documents/files/doc_2374.pdf

Key takeaways:

- The many valuable ecosystem functions and services that coastal and marine ecosystems provide are tightly interlinked.
- Assessing and valuing ecosystem services entails understanding how Blue Carbon ES are inter-linked, assessing environmental conditions, understanding the way these services are valued and perceived in the local context, and assigning values.
- A better recognition of ecosystem services values - not just monetary but also their role in promoting better understanding of how ecosystems function and how they might be better managed, as well as non monetary values, such as cultural and spiritual values - can catalyze better policy and management practices.
- A combined Blue Carbon and ecosystem services approach may be necessary to secure the sustainable management of Blue Carbon ecosystems.

Mangroves of the United Arab Emirates - cultural heritage as a significant driver for the conservation of Blue Carbon ecosystems

While Mangroves are suffering degradation and decline worldwide, the United Arab Emirates (UAE) may be the only country where this key Blue Carbon habitat experiences positive growth in area. This is due to the tremendous impact and inspiration of the legacy of the late Sheikh Zayed Bin Sultan Al Nahyan, who in recognizing the importance of mangroves to the UAE, instituted a massive mangrove reforestation campaign. This effort has continued since the 1970s with the UAE becoming a global leader in mangrove reforestation. A current Environment Agency Abu Dhabi (EAD) initiative involves the planting of 2 million mangroves. The late HH Sheikh Zayed's policies have harnessed the cultural value of mangroves as a significant driver for their conservation.



5 Blue Carbon and Coral Reefs

Often referred to as the “rainforests of the sea,” coral reefs represent one of the most productive, diverse, and magnificent marine habitats on the planet. Although not Blue Carbon ecosystems, coral reefs can be intrinsically connected and related to Blue Carbon habitats and should be considered when developing Blue Carbon projects.

Why Coral Reefs are not Blue Carbon

Coral reefs build massive calcium carbonate (limestone) structures in shallow tropical seas. Although these ecosystems cover less than 0.1 percent of the world’s surface area, they are responsible for burying about half of the limestone in the oceans. Because they produce such large amounts of limestone it is often assumed that these ecosystems must be sinks for atmospheric carbon. However, this is not the case, because when calcium is precipitated by corals during calcification (the process by which living organisms deposit inorganic carbon in solid form to make calcium carbonate skeletons or shells) carbon dioxide is actually generated rather than consumed. This has been known for well over a century.

Other biological processes, in addition to calcification, also impact the amount of carbon dioxide produced or consumed by reef ecosystems. These metabolic processes include respiration, which produces carbon dioxide, and photosynthesis, which consumes carbon dioxide. Some reef areas, such as shallow reef flats, can be dominated by photosynthesizing organisms, such as seaweeds and seagrasses, which are a sink for carbon dioxide. However, most other reef areas are inhabited by many non-photosynthetic organisms whose respiration is a source of carbon dioxide. Consequently, in most reef systems, photosynthesis and respiration tend to balance each other out, and the net result contributes little to the overall carbon dioxide budget for reefs which is dominated by the effects of calcification.

As a result of these combined processes, reefs are net sources of carbon dioxide that globally contribute 0.02 - 0.08 billion metric tons of carbon dioxide per year to the atmosphere (Ware *et al.*, 1992). This is a tiny fraction (no more than about 0.2 per cent) of the amount contributed by fossil fuel emissions (which reached 36 billion metric tons in 2013) (Carbon Dioxide Information Analysis Center, 2013). Consequently, although reefs are net sources of carbon to the atmosphere, their contribution is negligible compared to the combustion of fossil fuels.



Image credit Glenn Edney



Coral reefs can be intrinsically connected and related to Blue Carbon habitats and should be considered when developing Blue Carbon projects. The reef, seagrasses and mangroves pictured from above are located off Ambergris Caye, Belize (image credit Jason Valdez/Marine Photobank).

A Ridge to Reef Approach for Blue Carbon

Coral reefs are an associated Blue Carbon ecosystem even if they may not be a Blue Carbon sink. Given the important ecological and ecosystem service connections and linkages between these habitats, mangroves and seagrasses can be regarded as vital parts of greater coral reef ecosystems.

The health, abundance, and diversity of the organisms that make a coral reef ecosystem are directly linked to the surrounding terrestrial and marine environments. The complex root systems of mangroves help stabilize the shore lines, while filtering runoff and nutrients, protecting coral reefs from land-based pollution. Their submerged roots and detritus provide nursery, breeding, and feeding grounds for many animals found on coral reefs. Mangroves have been found to strongly influence the community structure of fish on neighbouring coral reefs, including a more than doubling of biomass for several commercially and recreationally valuable species when their life cycle habitat is connected to mangroves (Mumby *et al.*, 2004). Seagrass meadows often form in lagoon areas between mangrove habitats and coral reefs. They serve as the foundation of many marine food webs and also provide food and shelter for coral reef associated species. Additionally,

coral reefs protect mangrove and seagrass habitat from currents, waves, and storms. Healthy reefs can slow incoming waves, dissipating much of the force.



Many commercial and recreational fish and shellfish species share Blue Carbon and coral reef habitat such as these White Margate off Ambergris Caye, Belize (image credit Steven J Lutz, Blue Climate Solutions).

Coral reef ecosystems are also vital to the livelihoods and well-being of many coastal and island communities around the world. Healthy reefs have positive spill-over effects on local economies. These effects include replenishment of fish stocks and the potential for sustainable alternative livelihoods to fishing, thanks to increased tourism revenues and restoration of ecosystem services such as shoreline protection. Tourism and fisheries are two of the main economic pillars for many coastal and island states and healthy coral reef ecosystems are critical to both. As nature-based coastal tourism is one of the hospitality industry's fastest growing sectors and food security is a pressing issue for coastal and island states, the value of healthy Blue Carbon and associated ecosystems is likely to rise.

Figure 7 illustrates the crucial linkages between terrestrial ecosystems, adjacent Blue Carbon ecosystems, and coral reefs. When occurring together and in healthy states, the ecological linkages and ecosystem services of mangroves, seagrass beds, and coral reefs are vital to one another and to the long-term health and sustainability of greater coral reef ecosystems. A 'ridge to reef' approach to Blue Carbon projects follows an ecosystem approach, which can help address land-based impacts, protect connected corridors between these habitats, and maintain the resilience and productivity of greater coral reef ecosystems.

Key takeaways:

- Coral reefs are not considered Blue Carbon sinks but they are an associated Blue Carbon ecosystem of significant value.
- When occurring together, coral reefs are an important associated Blue Carbon ecosystem, and mangroves and seagrass beds can be considered part of greater coral reef ecosystems.

- A 'ridge to reef' approach for Blue Carbon projects could help protect connected corridors between Blue Carbon habitats and coral reefs and maintain the resiliency and productivity of greater coral reef ecosystems, especially by reducing land-based threats such as sedimentation, nutrient enrichment and pollution runoff.

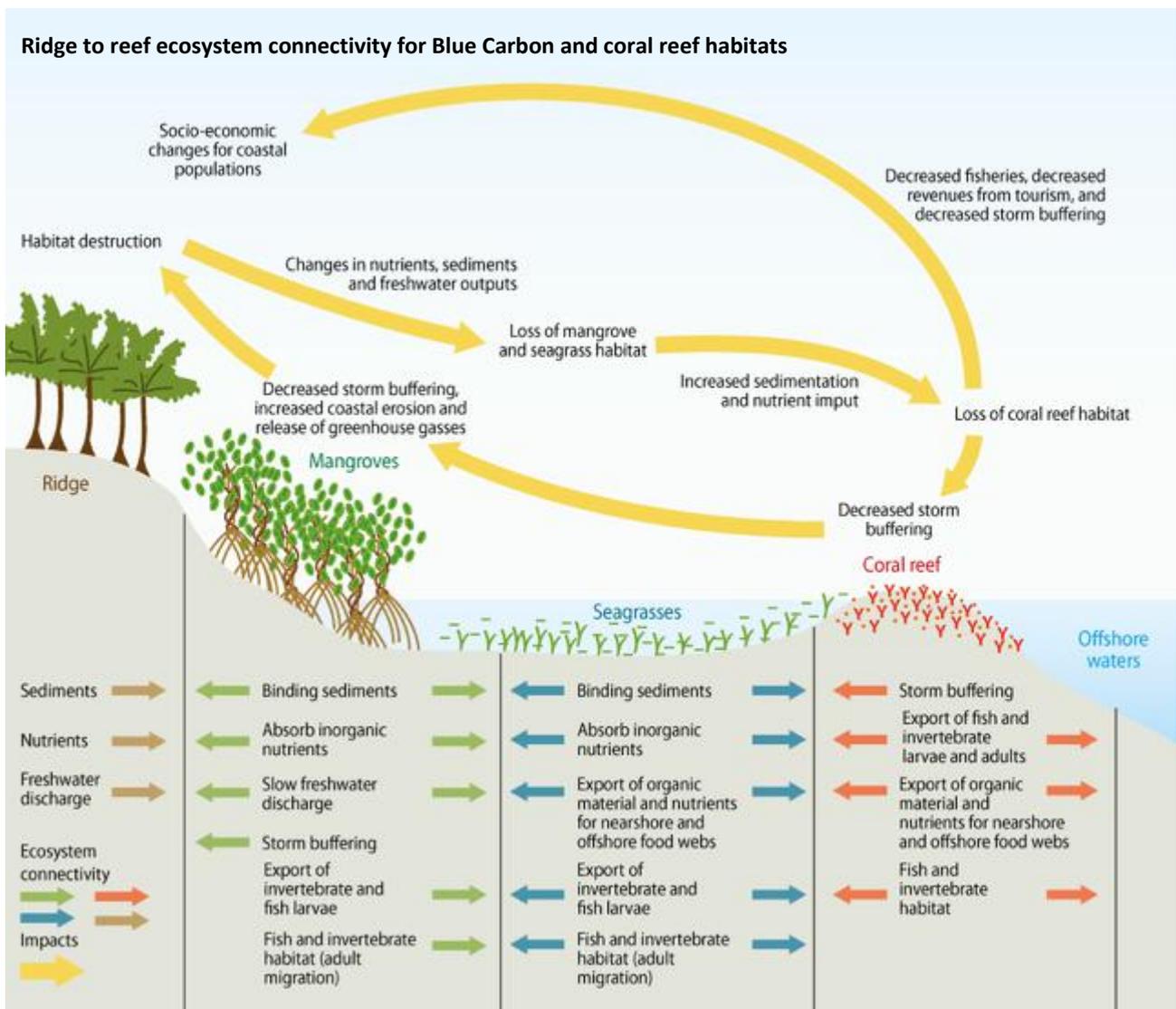


Figure 7 'Ridge to reef' ecosystem connectivity for Blue Carbon and coral reef habitats, including impacts on ecosystem services from human activities (adapted from WCMC, *Framing the Flow*, 2010).

6 Blue Carbon Capacity Building

As the Blue Carbon concept builds momentum, one of the central activities for project consideration is the capacity of local communities, scientists, and policy makers interested in and engaged in Blue Carbon activities and projects. This will help ensure that once project developers become far removed, the local capacity exists to carry-on project activities such as carbon monitoring and evaluation, and that the project continues to deliver benefits over the long-term. Blue Carbon projects offer a wide range of capacity building opportunities for many parties from community members, to students, to local and regional scientists to environmental managers and policy makers.

The following quotes illustrate the national and international experiences in Blue Carbon capacity building provided by the Abu Dhabi Blue Carbon Demonstration Project. The project represented a milestone in Blue Carbon by bringing together a team of national and international students, environmental managers, scientists and other professionals, and has helped enhance capacity in the UAE, Madagascar and Indonesia.



Mangrove sediment coring in Abu Dhabi.

“Being part of this project will enhance my future career and is a great experience to be involved in an international study of mangrove and other habitat here in Abu Dhabi.”

Fatima Al Marzooqi, Student
Zayed University, UAE

“It is a great opportunity to meet with scientists in Abu Dhabi and ask about methodologies for Blue Carbon that I use with my team at home in Madagascar. This experience will help safeguard the ecological goods and services critical to increasingly poor and vulnerable Malagasy coastal communities, while also safeguarding critical biodiversity.”

Lalao Aigrette, Senior Mangrove Scientist
Blue Ventures, Madagascar

“I’ve been working with the Blue Carbon science team and have learned so much about the ecology of the mangroves. With the team I’ve learned the methodology for assessing the biomass for mangroves and for taking carbon stocks in sediments. In the future we’ll be able to do this kind of work independently.”

Edwin Grandcourt, Manager of the Marine Assessment and Conservation Division
Environment Agency Abu Dhabi, UAE

“I was lucky enough to be involved in the Blue Carbon field work where I got exposed to information I had not known before. From the visiting scientists, our team learned the methodologies for measuring carbon stocks under the mangroves. Now, with this project we will be able to protect the mangroves better and benefit from them more – to help keep our air cleaner.”

Maitha Al Hameli
Environment Agency Abu Dhabi, UAE

Key takeaways:

- Capacity building within a Blue Carbon project can be accomplished at all levels, ranging from the local to the international.
- A variety of stakeholders and participants can and should be involved in Blue Carbon projects, including community members, students, field researchers, local business and other leaders, policy makers, and government authorities.



Field research team for the Abu Dhabi Blue Carbon Demonstration Project.

7 Lessons from REDD+

The United Nations collaborative program on Reducing Emissions from Deforestation and Forest Degradation (REDD+) is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development.

There is growing recognition that mangroves could be included under REDD+, however there remains a lack of clarity and inclusion of all Blue Carbon ecosystems, such as salt marshes and sea grasses. Of critical concern is the ability for an expansion of REDD+ to include soil carbon, therefore serving as a long-term and stable source of funding to protect Blue Carbon ecosystems and achieve the various goals of stakeholders.

The lessons from REDD+ in a Blue Carbon context are not very different from those of other successful payments for ecosystem service frameworks. These include the need to define project objectives, ensure clarity of administrative support and processes, and have capacity in country for monitoring, reporting and verification (MRV) (Fonafifo *et al.*, 2012).

Research from Gordon *et al.* (2011) has suggested that if REDD+ protocols were to evolve to include soil carbon as a carbon offset, it could have significant potential to enhance Blue Carbon projects. The REDD+ framework has a history of expanding in scope, as described by Olander *et al.* (2012), demonstrating its importance and potential as a framework for payments for Blue Carbon projects.

A challenge for REDD+ projects is demonstrating that local people living in and or adjacent to the project areas have been meaningfully engaged in the design of the projects, support the projects, and will benefit significantly from project implementation. The expectation of carbon standard organizations is that the developers of such projects can credibly demonstrate local communities' free, prior, and informed consent (commonly referred to as FPIC). Often, project developers and local communities have difficulty agreeing on what constitutes a community's fair share, given differences of opinion regarding the returns that should be associated with the risks that the developers incur, as they typically pay for all the upfront development costs and do not have assured carbon credit purchase agreements in place prior to developing the projects in question. Even when an agreement is reached, ensuring that such local communities obtain a fair share of the future credits, in recognition of their historical stewardship roles, and or the opportunity costs they incur in not utilising the project areas, is often complicated by a lack of clarity regarding land tenure, ownership of forest resources, the associated carbon rights, and or the legal ability to enter into commercial agreements regarding such rights

It is important for those interested in developing Blue Carbon projects to devote adequate attention to these and other issues and to seek to address these early during the due diligence and design process. One approach that helps address the transparent and accountable disbursement of carbon credit revenues is the creation of community trust funds, ideally with a professional board and fund manager, who provides regular, detailed reporting on the receipt and use of such funds.

In light of the numerous complexities surrounding REDD+, several leading actors are increasingly turning away from the development of individual projects in favour of promoting larger-scale approaches where the baseline analysis and associated measurement, reporting, and verification (MRV) are conducted at a sub-regional, or regional level, typically within existing political boundaries within a country. This approach is referred to as jurisdictional, nested REDD+ (JNR). Although this approach is still relatively new, it offers several advantages over the individual project approach. The specific details of such approaches are still being determined in most cases, but in general bilateral and multilateral donors seem to be increasingly interested in supporting such approaches and making payment for achieving emissions reductions over time. Another new approach is the support of Nationally Appropriate Mitigation Actions (NAMAs) for the forestry sector, including mangroves and using a similar higher-level MRV approach. Such approaches are particularly relevant for efforts to protect existing Blue Carbon ecosystems.

Further information on Blue Carbon and REDD+ can be found in the following:

Assessment of carbon pools and multiple benefits of mangroves in Central Africa for REDD+ (Ajonina et al., in press)

- In press -

Financing Options for Blue Carbon: Opportunities and Lessons from the REDD+ (Gordon et al., 2011)

<http://nicholasinstitute.duke.edu/sites/default/files/publications/financing-options-for-blue-carbon-paper.pdf>

Lessons Learned for REDD+ from PES and Conservation Incentive Programs: Examples from Costa Rica, Mexico and Ecuador (Fonafifo et al., 2012)

<http://www.forest-trends.org/documents/index.php?pubID=3171>

Key takeaways:

- Complex issues such as high project costs, fluctuating carbon prices, and the involvement of multiple actors surround REDD+ projects and necessitate comprehensive planning measures.
- It is important to develop a coordinated, measured and cautious approach when advancing Blue Carbon ecosystems under REDD+ strategies.
- Land tenure and other governance issues need to be clarified at the onset, in order to ensure equitable and or appropriate allocations between local communities and project developers and to avoid conflict and further complexities during the process.
- REDD+ methodologies for avoided deforestation in Blue Carbon ecosystems need to expand beyond voluntary standards.
- Engage with local communities early in the project design process and explore use of community trust funds to prove intention.
- Ensure transparent and accountable disbursement of carbon credit revenues.

8 Case Studies

8.1 Abu Dhabi Blue Carbon Demonstration Project

In just over 40 years, Abu Dhabi has evolved from a small fishing community to the most populated of the seven Emirates of the United Arab Emirates (UAE). With the foresight and vision from His Highness the late Sheikh Zayed Bin Sultan Al Nahyan, the environment has become an intrinsic part of the preserved heritage and traditions of the people of the UAE. This national affinity for the environment has led to the initiation of the Abu Dhabi Blue Carbon Demonstration Project, with the aim of exploring the value that coastal and marine ecosystems provide in the UAE, with a focus on carbon sequestration, and to help preserve the Emirate's environmental and cultural heritage. The project studied the full range of Blue Carbon ecosystems (mangroves, saltwater marshland seagrass) as well as cyanobacterial algal mats and coastal sabkha, two ecosystems of particular local interest.

The project was developed as an integrated assessment of the extent of coastal and marine ecosystems, the carbon they sequester and store, the further ecosystem services they provide, as well as the policy and financial options for recognizing Blue Carbon ecosystems' value in Abu Dhabi's decision making (Figure 8).

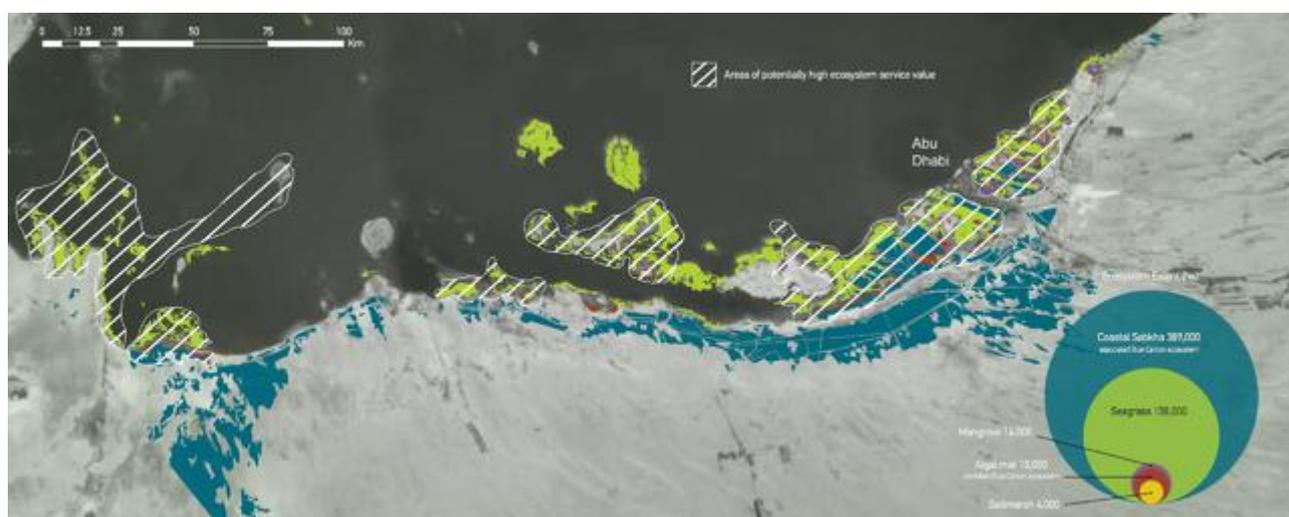


Figure 8 Estimated areas of highest concentration of Blue Carbon co-benefits arising from Blue Carbon and candidate and associated ecosystems (AGEDI, 2013).

Two field missions brought together world-experts on carbon science, mapping and ecosystem service valuation, with local volunteers, local scientists and agency staff, and international Blue Carbon practitioners. The missions allowed participants to share expertise and knowledge, and to jointly create a better understanding of how Blue Carbon supports the well-being of the people of Abu Dhabi, the region and the globe. Experts from Madagascar and Indonesia were able to participate in the field missions, thereby representing a global first in international Blue Carbon scientific exchange. The visiting experts represented partners from the Global Environment Facility (GEF) Blue Forests Project (Blue Ventures and the Government of Indonesia), providing important capacity in Blue Carbon to these nations.

The team found the carbon contents of the ecosystems to be significant on a local scale, while on the lower end when compared to non-arid regions of the world. Seagrass is by far the most extensive Blue Carbon ecosystem in Abu Dhabi, and it is also important as a habitat for dugong and sea turtle populations. Overall, ecosystem services beyond carbon sequestration and storage, such as shoreline stabilization, support to fisheries, direct recreational use, and water quality maintenance were found to provide a larger share to overall value. Figure 9 illustrates the relation of project components.

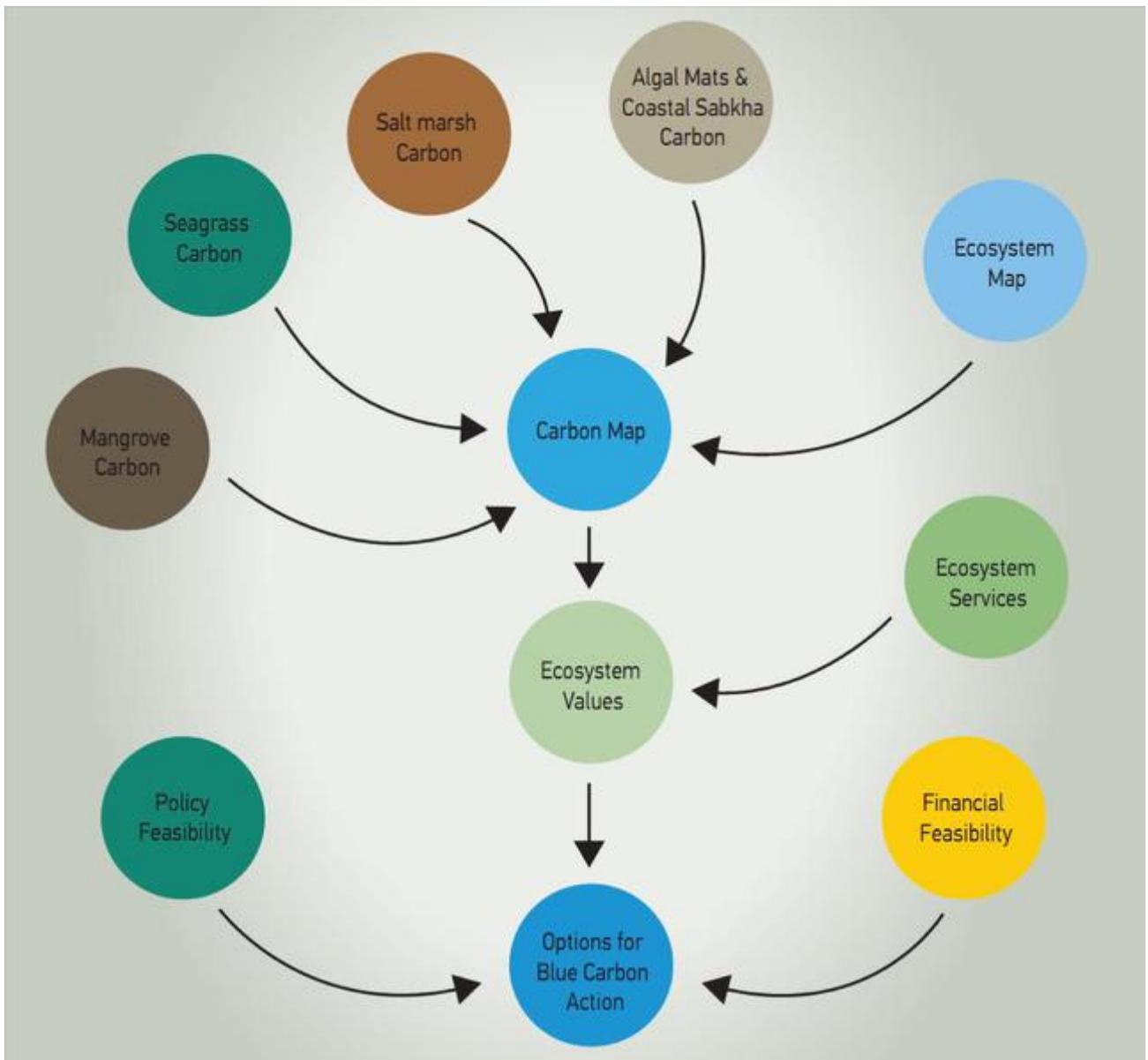


Figure 9 The relation of components of the Abu Dhabi Blue Carbon Demonstration Project.

Two ecosystems were studied that are special to the local environment. Coastal sabkha is a coastal salt flat ecosystem. It can be flooded several times per year when exceptionally strong shamal winds drive seawater inland. Coastal sabkha is largely devoid of vascular vegetation because of hypersalinity and long periods of dry conditions, and does not sequester carbon. However, it can serve as a cap to carbon deposited earlier by other ecosystems, and it is therefore considered an

associated ecosystem. Along tidal margins of coastal sabkha where soils are consistently moist, algal (cyanobacterial) ‘leather-like’ and moist mats are formed, with a laminated fabric of up to tens of centimetres. Algal mats were found to store significant amounts of carbon, and present a ‘candidate’ Blue Carbon ecosystem to be studied further.

A team of policy and finance experts consulted extensively with stakeholders from over 20 local and national institutions, agencies, and organizations, to learn how Blue Carbon ecosystems were valued in the Emirate and identify which avenues were most attractive and feasible for conservation. The project team recommends the following three options to Abu Dhabi that would support the recognition and protection of Blue Carbon ecosystems and the services they provide in the Emirate.

1. Abu Dhabi could include the ecosystems in their Greenhouse Gas Inventories and reporting to UNFCCC.
2. Ecosystem-based Management (EBM) and Marine Spatial Planning (MSP) offer opportunities to improve the management of these ecosystems, and high service delivery sites in particular.
3. The conservation and creation of Blue Carbon ecosystems could be supported through a dedicated Specialised Fund that would be supported through offset funds from developers in coastal and marine areas. The generation of carbon credits through a certification project was considered unattractive due to challenges over the financial net benefit as well as eligibility considerations.

“Mangroves, along with the coastal ecosystem are key to maintained and improved sustainability of our Emirate. The Abu Dhabi Blue Carbon Demonstration Project is an invaluable initiative, not only for the duration of the project but beyond. The experience and knowledge gained from this local project will help pave the way for other national Blue Carbon projects and international efforts for a greener economy and natural climate change mitigation.”

H.E. Razan Khalifa Al Mubarak
Secretary General, Environment
Agency Abu Dhabi (EAD)

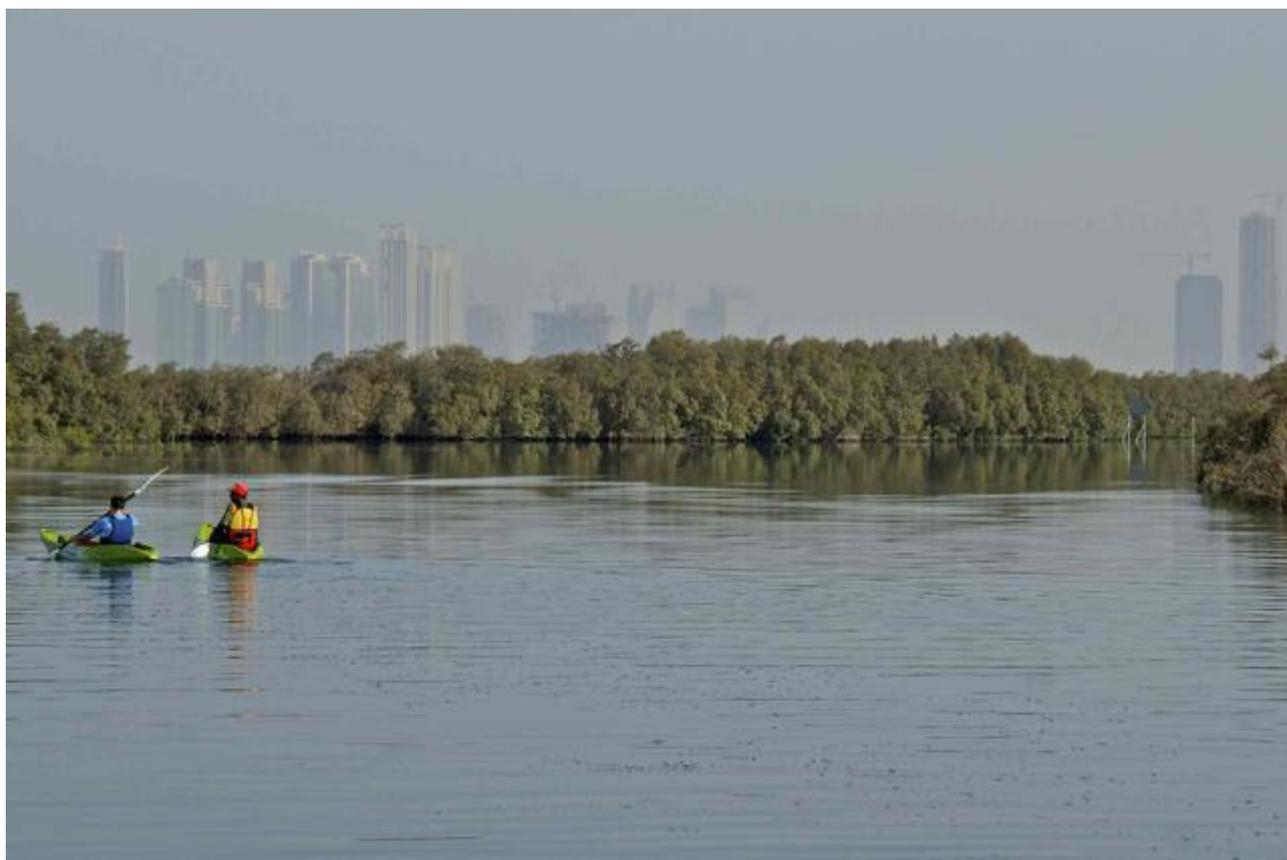
The project has been presented to many local, regional and international parties and been recognized as a featured intervention of the GEF Blue Forests Project, a major global UNEP initiative. Significant results to-date includes the following:

- The Emirate of Dubai will be utilising the project’s methodology and ecosystem services habitat protocols for carrying out similar assessments;
- The Northern Emirates, especially two important sites may be incorporated into future AGEDI Blue Carbon work;
- Project findings have been incorporated into Abu Dhabi’s National Biodiversity Strategies and Action Plans (NBSAP) report;
- Project findings have been incorporated into Abu Dhabi’s Environmental Performance Index (AD-EPI) report;
- Project findings have been incorporated into Environment Agency Abu Dhabi (EAD) business planning towards the Climate Change programme;

- Project findings have been directly incorporated into the Abu Dhabi 2030 Urban Structure Framework Plan (Abu Dhabi Capital 2030), planning for the Al Gharbia Region (Al Gharbia 2030) and marine spatial plans; and
- Project findings have been used by the Abu Dhabi municipality.

Overall, the project has informed Abu Dhabi’s decision-making on Blue Carbon ecosystems, and provides decision-makers with highly promising options for action to support the conservation of the Emirate’s marine and coastal environment. Internationally, the Abu Dhabi Blue Carbon Demonstration Project presents excellent policy options, success stories and examples of lessons learned for the application of Blue Carbon through the other international efforts including the GEF Blue Forests Project (Case Study 8.6).

All project assessments, reports and materials are available on the
Abu Dhabi Blue Carbon Demonstration Project web site:
<http://abudhabi.bluecarbonportal.org>



Blue Carbon ecosystems support many uses such as Kayaking in the mangroves in Abu Dhabi.

8.2 Mikoko Pamoja - Community-led Mangrove Carbon Conservation Project in Kenya

Located 65 kilometres south of Mombassa, Kenya, Gazi Bay is home to several villages surrounding a mangrove forest. Local communities depend on the mangroves for wood (e.g. building poles and firewood) and non-wood forest products as well as services such as seafood, and traditional medicine. However, the mangroves have been extensively degraded since the 1970s, through commercial logging and conversion of mangrove habitat to other uses, particularly agriculture and coastal development. Loss of

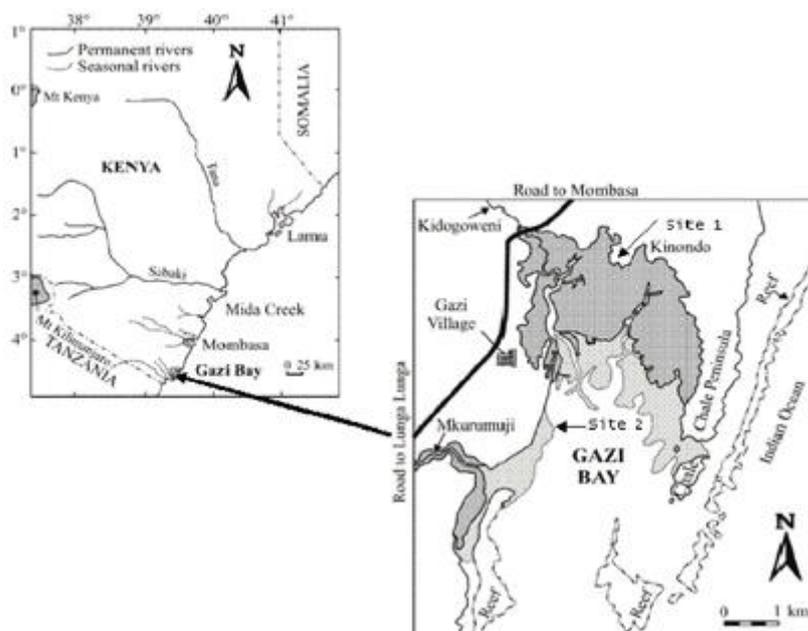


Figure 10 Mikoko Pamoja project site in Kenya (Plan Vivo, 2010).

of mangroves has led to shortages of firewood and building materials, a decline in fisheries, and increased coastal erosion. Hence, there is an urgent need for the rehabilitation, conservation, and sustainable use of the mangroves at Gazi Bay.

Gazi Bay is the site of the Mikoko Pamoja project (Figure 10), the first community-led mangrove conservation project to be certified for carbon finance by the voluntary carbon market. Project activities include, mangrove conservation, reforestation of degraded areas, and reduced impact logging in an area covering 107 hectares. The estimated 3,000 tons CO₂-equivalent of carbon credits generated through the project are sold into the voluntary carbon market; generating approximately U.S. \$12,000 per annum to the local community.

Partners of the Mikoko Pamoja project (translated as “mangroves together”) include: Kenya Marine and Fisheries Research Institute (KMFRI), the project host and lead government institution; Aviva, a multinational insurance company and the project funder; Earthwatch Institute, a volunteer organization; Edinburgh Napier University, a research institution; and other Kenyan government institutions and local stakeholders.

The Mikoko Pamoja project is verified under the Plan Vivo Standard, a framework for supporting communities to manage their natural resources more sustainably, with a view to generating climate, livelihood, and ecosystem benefits through payments for ecosystem services - in this case carbon. The project was initiated in June 2010, and in October 2013 it was officially given permission to start operations by the Kenyan Government through the issuing of a Forest Management Agreement to the Gazi Bay community, and the project is currently awaiting certification by Plan Vivo. Payments for mangrove carbon are expected to be realised in 2014.

An agreement regarding the use of money generated by the sale of mangrove carbon credits was negotiated with the Gazi Bay community during the project design process. The community is represented by the Mikoko Pamoja Community Based Organization. One third of the total annual carbon income generated through Mikoko Pamoja (approximately U.S. \$4,000) will be used for rehabilitation and protection of mangroves. Figure 11 illustrates the anticipated financial flow from the external buyers of carbon credits sold on the voluntary carbon market, through to the different project components.

Through the Mikoko Pamoja experience, it is expected that coastal communities throughout Kenya and potentially internationally will benefit from mangrove conservation, restoration and protection supported with revenue from carbon credits. This also includes lessons learned from Mikoko Pamoja contributing to the Global Environment Facility’s Blue Forests Project, a UNEP initiative to implement better coastal ecosystem management by harnessing the values associated with carbon and ecosystem services at a number of demonstration sites throughout the globe.

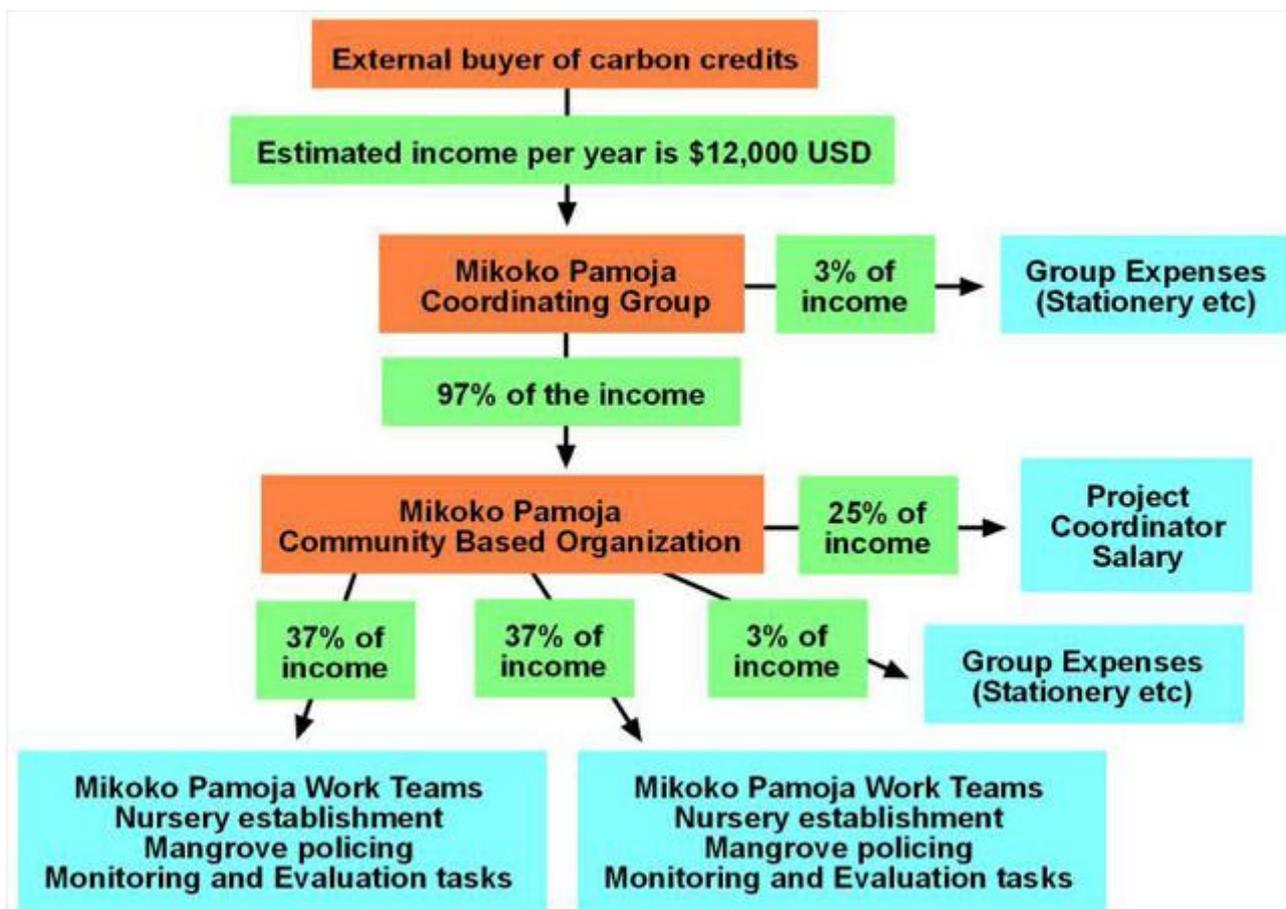


Figure 11 Negotiated financial flow of Mikoko Pamoja.

8.3 Building the Case for Blue Carbon in Madagascar

Covering approximately 2,800 square kilometres, Madagascar has Africa's fourth largest extent of mangrove ecosystems. Mangroves provide critical goods and services to surrounding Malagasy communities including a significant majority of the energy needs for rural populations, primarily through logging activities to obtain charcoal and firewood. Despite the ecological benefits provided by mangroves, in many parts of the country degradation and rate of loss continues to increase. Presently, any large-scale or comprehensive management initiatives to curb or reduce degradation and deforestation are absent. Hence the dire need for innovative approaches that can support sustainable management, such as Blue Carbon.

Blue Ventures, a social enterprise with a presence in Madagascar, has a proven record of novel, holistic marine conservation initiatives that directly improve livelihoods in some of the world's poorest coastal communities. Blue Ventures has been exploring Blue Carbon's potential to promote sustainable management since 2011. Through their Blue Forests project, Blue Ventures has been assessing the feasibility of and developing forest carbon (or REDD+) and other payments for ecosystem services projects centred on the conservation and sustainable use of mangrove forests. These projects all aim to build resilience to climate change, improve local livelihoods, safeguard biodiversity, and help mitigate global climate change. Through the Blue Forests project, sixteen full-time staff are currently engaged with communities across six sites along Madagascar's west coast (Figure 12). The team includes conservationists, field technicians, geospatial analysts, ecologists, socioeconomic scientists, and community organizers.

A key aim of the Blue Forests project is to, in time, build community-led projects that will empower coastal communities to equitably participate in mangrove REDD+. If such projects are to be built, methodologies specific to mangroves are necessary. To accomplish this, the team has spent much of 2013 working through a Verified Carbon Standard (VCS)-approved methodology for avoided deforestation projects - a methodology developed for terrestrial forests. By working through this approved methodology in its entirety, the project is making robust estimates of the

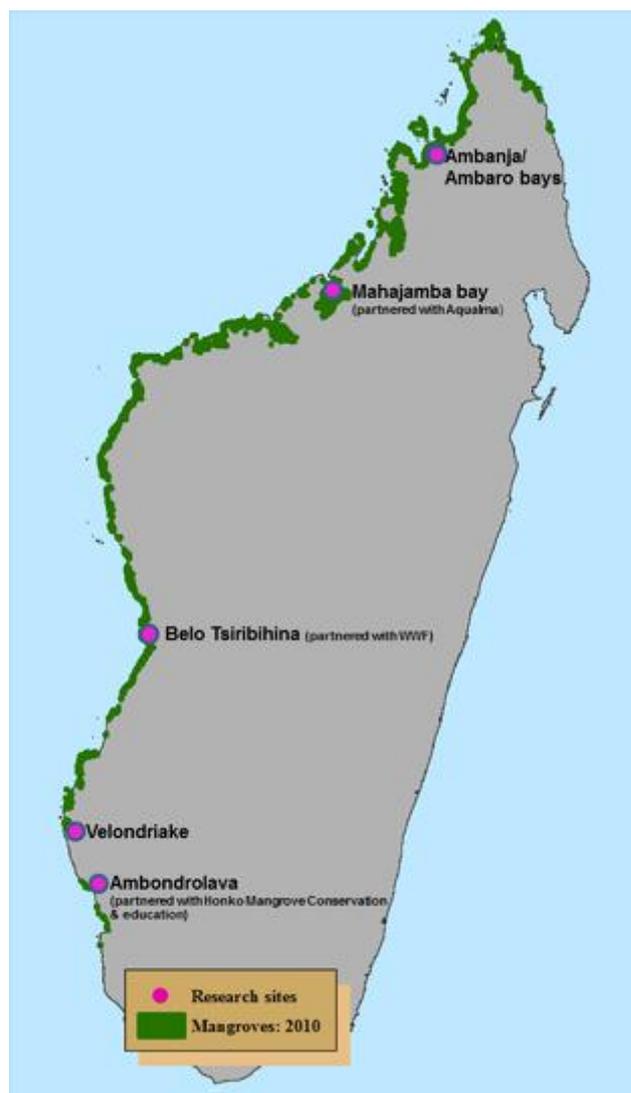


Figure 12 Blue Carbon project sites in Madagascar.

greenhouse gas emission reductions achievable through mangrove REDD+ in Madagascar, as well as contributing towards new VCS methodologies applicable to the avoided deforestation of mangrove forests and the conservation of intact mangrove wetlands anywhere in the world.

Because REDD+ projects can take many years to establish and operate within significant market and policy uncertainty, the Blue Forests project is going beyond carbon to create shorter-term ways for coastal communities to gain from sustainable management of mangrove fisheries and forest resources.

Across their five sites, Blue Forests team members, in close cooperation with community members, are involved in many activities, including:

- taking the measurements necessary to estimate above- and below-ground carbon stocks in mangrove forests;
- collecting sediment core samples from deforested areas to understand the breakdown of carbon over time;
- using moderate-resolution satellite imagery in spatial analyses to stratify mangrove ecosystems and quantify ecosystem dynamics;
- engaging with local communities to understand the drivers of ecosystem degradation and deforestation – here, this often means over harvesting for charcoal production and building their capacities to manage mangroves sustainably;
- investigating strategies to reduce mangrove deforestation and estimating potential emissions reductions from avoided deforestation;
- assessing the social impact of continued versus altered land-use practices;
- analysing traditional forest user rights, tenure, and laws affecting implementation of REDD+ projects;
- establishing baselines with-project biodiversity scenarios and biodiversity monitoring programs and or mechanisms;
- contributing to shoreline protection through participation in mangrove restoration efforts; and
- establishing temporary community-managed fishing closures and mangrove fishing reserves.

Looking forward, Blue Ventures' Blue Forests project is strengthening the methodologies that can account for mangrove forests and paving the way for community REDD+ projects along Madagascar's mangrove-rich west coast. In the process, the project is helping build capacity within and bring immediate benefits to participating communities. Benefits are focused on conservation, improved management of mangrove forest and fisheries resources, and improved or alternative livelihoods.

"We expanded our scope to include blue forests (Blue Carbon) because we strive for a holistic approach to marine conservation that considers both communities and surrounding ecosystems. Without this landscape-scale, socio-ecological approach, our efforts could not help to truly empower coastal communities and improve their long-term livelihoods and climate change preparedness, while helping to safeguard biodiversity."

Trevor Jones, PhD
Geospatial Analyst, Manager of
Blue Carbon Science, Blue Ventures

Through replication activities, other coastal communities throughout Madagascar and internationally will gain understanding of the Blue Forests concept and may implement similar strategies for creating revenue and improving ecosystem management through the valuation of carbon and other service mangroves provide.



Blue Ventures Blue Forests team in Madagascar (image credit and © Garth Cripps, Blue Ventures).

8.4 An Integrated Blue Carbon Program for the Indonesian Archipelago

Indonesia features vast Blue Carbon and associated ecosystems, mangroves in particular. Yet Indonesia's mangrove forests are also among the world's most threatened habitats. Annually, three-to-seven per cent of Indonesia's mangroves are degraded by dredging, deforestation, aquaculture, and unsustainable use by local fishermen (Hutahaean, 2012). Indonesia's seagrass beds are also threatened and it is estimated that about 30-40 per cent of its seagrass beds have been lost (UNEP, 2004).

A research team from Indonesia's Agency for Research and Development of Marine and Fisheries has been overseeing a field project across four sites within the Indonesian archipelago (including Derawan Islands - East Kalimantan, Tomini Bay - North Sulawesi, Banten Bay and Tanjung Lesung - Banten) to study mangroves and seagrass ecosystems. This Blue Carbon project has been funded by the Ministry of Marine Affairs and Fisheries, Republic of Indonesia.

This research seeks to promote the sustainable management of those ecosystems, by first establishing a robust scientific case about their carbon sequestration and storage capacities.

Teams of local scientists and researchers have collected samples of mangrove and seagrass biomass and sediment for analysis of their carbon content and sequestration ability. The team collected samples from different types of sites, both rehabilitated and intact mangroves. Analysing these sites for comparison allows scientists to better understand the sequestration abilities in relationship to land conversion.

The field team also carried out extensive mapping activities of both types of ecosystems, in order to conduct spatial analysis for the extent and ecosystem degradation over time. One of the challenges here is obtaining good quality remote sensing images for seagrasses. Thus, an aim of



Measuring trunk diameter at breast height (DBH) of mangrove ecosystem in Derawan Islands, East Kalimantan, Indonesia.



Quadrant transect for observing seagrass ecosystem in Tomini Bay of North Sulawesi, Indonesia (Images credit BALITBANG KP.).

researchers is to improve their access to higher resolution images – an activity they are working on in partnership with other international Blue Carbon scientists.

The work is done by a combined group of local non-governmental organizations and academic researchers who participate in research, analysis, and in conveying the findings to decision makers at the government level.

Presently, this research focuses on expanding the science and filling in data gaps, though there certainly are longer-term goals of engaging with local communities to better understand the importance of these ecosystems and their provision of ecosystem services.

One of the main focuses of this work is to bring together those within Indonesia in a forum for knowledge sharing and collaboration and to better understand the science and policy around Blue Carbon in Indonesia. Further to this, in the last quarter of 2013 Indonesia put forth a National Science Plan that collates input from regional and national scientists to coordinate an action plan and a uniform understanding on Blue Carbon in Indonesia. Both activities are noteworthy, as they are the first of their kind and greatly needed in Indonesia where numerous Blue Carbon activities are underway. The Indonesian community of local non-profit organizations, scientists, governments and community stakeholders will convene in a roundtable effort to map current field activities and prevent any overlap of efforts, as well as find areas for partnership in the field. The forum and the National Plan are bringing together the many Blue Carbon activities in Indonesia, presenting a coordinated effort to convey information to decision makers about the importance of conserving and sustainable use of Indonesia's Blue Carbon ecosystems.

Furthermore, in late December 2013, Blue Carbon Research Group, Agency for marine and fisheries research and development along with other International partners (German International Cooperation (GIZ), Conservation International, Arafura and Timor Seas Ecosystem Action Program (ATSEA) and IUCN) organize the 1st International Workshop on Blue Carbon in Jakarta. This workshop was dedicated to bridging the gap between science and policy in Blue Carbon by providing a framework for science development that maximizes sustainable use, rehabilitation and conservation of the coastal ecosystems.

Indonesia's Blue Carbon efforts will continue 2014 and beyond, as Indonesia is an Intervention of the GEF Blue Forests Project. The GEF Blue Forests Project will add additional value to efforts already underway, by expanding the sites where field work is conducted and attempting valuation activities for the ecosystem services provided by Indonesia's mangroves and seagrasses, along with accompanying capacity building with local experts (Figure 13). Expected outcomes from GEF support include improved capacity and ecosystem management supporting the sustainable use of mangrove and seagrass resources and reduced greenhouse gas emissions.

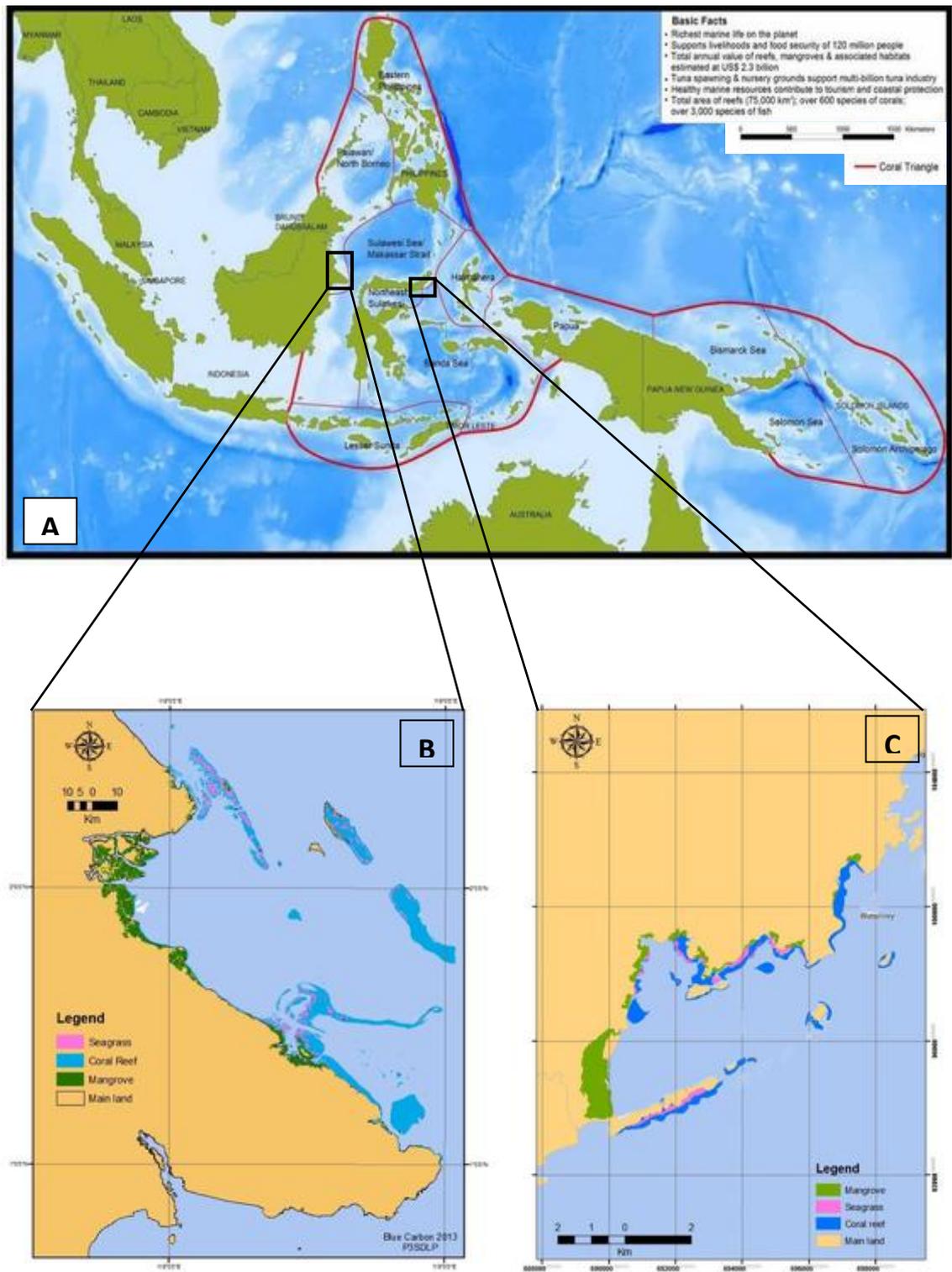


Figure 13 Indonesia, located amongst the most diverse coastal and marine ecosystem on earth known as the Coral Triangle (A). Demonstration sites of the Integrated Blue Carbon Project are located in Derawan Islands, Berau-East Kalimantan (B) and Tomini Bay, North Sulawesi (C).

8.5 Exploring Seagrass Climate Change Mitigation Potential in Thailand and Australia

One of the key Blue Carbon knowledge gaps for seagrass ecosystems is that the current scientific literature for seagrass carbon is mainly based on research from temperate areas, and extending such knowledge into tropical marine regions is vitally needed. Consequently, a study titled Nature-based climate change mitigations through management and restoration of seagrass meadows: quantifying the potential has explored seagrasses for their climate change mitigation potential at two tropical locations: the seagrass beds of Haad Chao Mai National Park, Trang Province, Andaman Sea, Thailand and Cairns Harbour, the Great Barrier Reef World Heritage Area (GBRWHA), Queensland, Australia.

The study was implemented by the IUCN Global Marine and Polar Programme (GMPP) in close collaboration with the University of Technology in Sydney (UTS) with funding from the TOTAL foundation. The project supported an international PhD student from UTS, who executed the research, using both laboratory and field-based experiments and observations. This work provided insights into the carbon storage of tropical seagrasses.

The project examined carbon in the sediments of pristine and degraded seagrass meadows and determined how much the loss and degradation of these systems affected their carbon storage capacity. The project showed that tropical seagrass meadows are equally important as temperate seagrass meadows for Blue Carbon storage, providing evidence that tropical living seagrasses are potentially one of the largest pools of organic carbon storage compared to global seagrass areas.

This research also confirmed that the below-ground biomass of seagrasses plays a more important role as a carbon stock than the above ground parts, storing five times more carbon in the roots than in the leaves and stems.

This research illustrated the first estimate of changes in the organic carbon stock stored in sediment after seagrass loss. Estimation of carbon stock showed that the carbon value of degraded sediment was five times lower than sediment from pristine seagrass beds. These results confirmed that seagrass loss results in carbon stock loss from the sediment. The study also produced the first emission factor for seagrass meadows, conveying what amount of stored carbon would be lost during habitat conversion. These numbers are extremely useful for resource managers when considering the impact of coastal development application.

This project is the first of its kind in Thailand, and possibly one of only three in Southeast Asia, including the Philippines and Indonesia. It contributed to the ongoing process of enhancing the capacity of professionals and in developing appropriate climate change policy, financing, and management mechanisms in Thailand. It extended current scientific understanding of the role of seagrasses in climate change mitigation, and provided new Blue Carbon data for a region lacking significant data. Furthermore, this data informed the global community about carbon stocks in tropical regions, which is relatively underrepresented in the current global databases.

8.6 The GEF Blue Forests Project

The Global Environment Facility's (GEF) Blue Forest Project presents a global milestone opportunity for advancing the blue forests concept - the sustainable financing of coastal ecosystem management through values associated with carbon and wider ecosystem services. The project will achieve this through a coordinated international approach combining research, policy development, technical advice and practical tools coupled with small-scale interventions (i.e., demonstration projects). The project will build on existing initiatives and projects to become a major global driver through proving the concept on the ground and it's up-scaling internationally.

The Blue Forests Project is a four year UNEP proposal focused on exploring carbon storage and sequestration and the valuation of other ecosystem services for 'blue forests' ecosystems (i.e., Blue Carbon ecosystems) globally and how these values can be used to support sustainable and improved ecosystem management.

The GEF project also focuses on addressing key knowledge gaps related to the valuation of carbon and related blue forests ecosystem services and the global uptake of methodologies and approaches developed in the project allowing for replication in other sites and mainstreaming into international policy, including through the GEF International Waters platform.

This major global initiative serves as an umbrella project, in which the concept of blue forests is explored through a series of shared experiences. The small-scale interventions will be supported by a project component focussed on providing support and local-scale guidance for carbon assessment, ecosystem services valuation and policy uptake.

GEF-funded interventions are located in Ecuador, Mozambique, Indonesia, Madagascar (Figure 14). The Abu Dhabi Blue Carbon Demonstration Project contributes to the Blue Forests Project as its featured intervention for the United Arab Emirates and is provided through 100% co-finance. The Blue Forests Project is expected to build further on the lessons learned in the Abu Dhabi Blue Carbon exploration and replicate successes. Replication and up-scaling activities are also planned in Kenya and Central America.

The Blue Forests Project was endorsed by the GEF in February 2014.

Partners of the GEF Blue Forests Project

- United Nations Environment Programme (UNEP)
- GRID-Arendal
- UNEP World Conservation Monitoring Centre (UNEP-WCMC)
- International Union for Conservation of Nature (IUCN)
- Blue Ventures
- Conservation International
- World Wildlife Fund (WWF)
- Abu Dhabi Global Environmental Data Initiative (AGEDI)
- Ministry of Marine Affairs and Fisheries-Indonesia
- UNEP Regional Office for Latin America and the Caribbean (UNEP-ROLAC)
- US National Oceanic and Atmospheric Administration (NOAA)
- US Forest Service
- Kenya Marine and Fisheries Research Institute (KMFRI)
- South African Institute of International Affairs (SAIIA)
- The Ocean Foundation
- Duke University
- Stockholm University
- Charles Darwin University

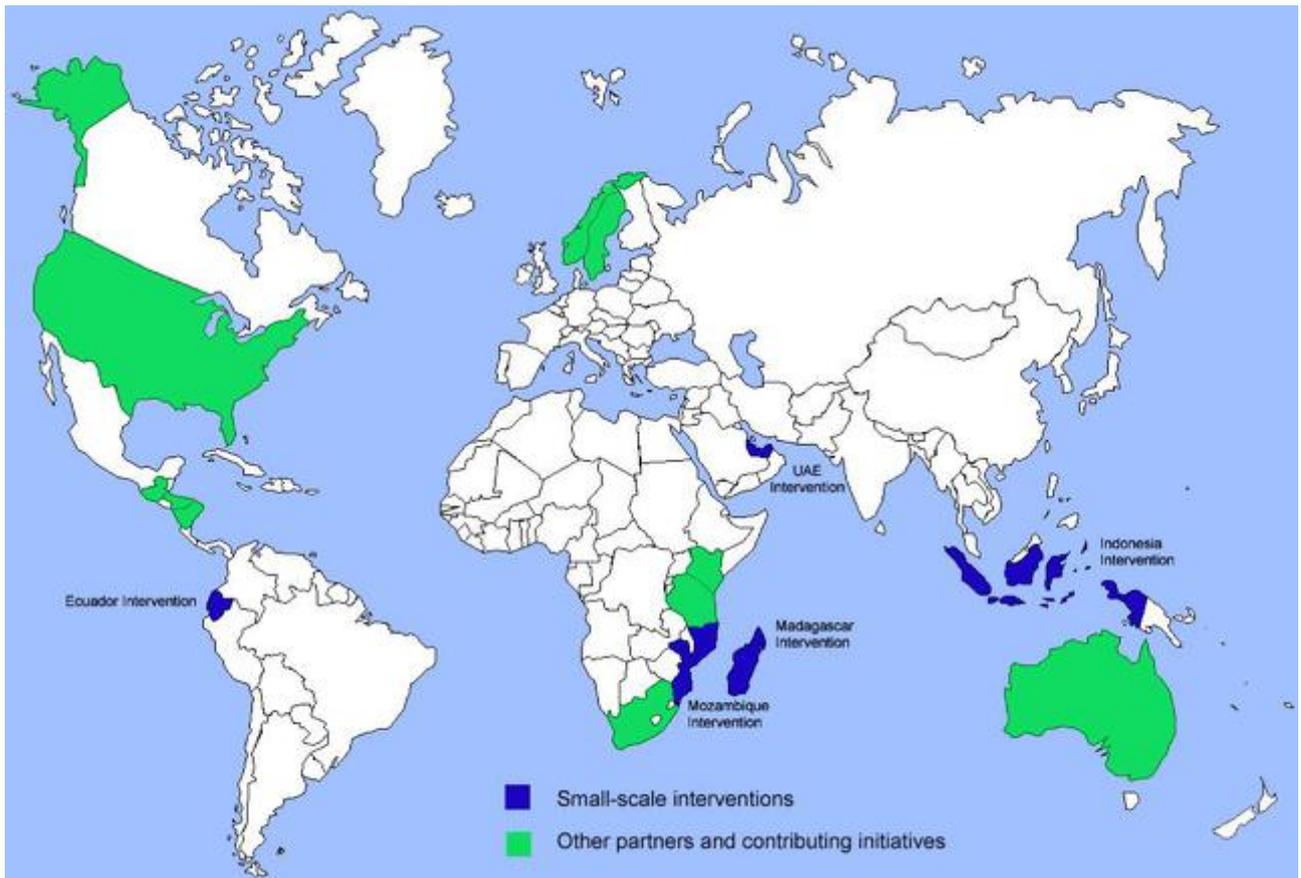


Figure 14 Global reach of the GEF Blue Forests Project.

9 Parting Thoughts

Considerable progress has been made in recent years in advancing Blue Carbon science and policy, and demonstration projects are beginning to be implemented worldwide. The groundwork for the viability of Blue Carbon values to be used for improved ecosystem management has been laid through the successes of the Abu Dhabi Blue Carbon Demonstration Project and other international initiatives. These experiences will continue to advance Blue Carbon globally through the GEF Blue Forests Project and other initiatives.

This guide has focused on Blue Carbon from a project development perspective. Using this lens, we have presented a sense of the variety of considerations one may take into account at the onset of project planning, provided insights into essential project elements throughout the project's planning, development, implementation and assessment, and described what a project might look like, including how to best build the capacity of local project managers who will ultimately be responsible for both ensuring project longevity and realising climate change mitigation benefits. This project-based perspective provides future project planners with the opportunity to learn from past trials and experience and build from field-tested experience. This guide also illustrates potential opportunities for using the value of Blue Carbon to mitigate climate change and improve ecosystem management

We are still in the nascent stages of Blue Carbon and can confidently estimate that Blue Carbon projects will be shaped and implemented differently, and with different results, across a variety of landscapes and political conditions. We stress that there is no rigid template for a Blue Carbon project and that a flexible approach to project development would be best suited to the varying conditions and objectives of each potential project around the globe.

Moving forward, Blue Carbon projects may result in a range of actions, such as the generation of carbon offsets, the policy recognition of ecosystem services, or conservation agreements. Despite the path a project takes, it is hoped that this guide can help to facilitate Blue Carbon projects that harness the climate change mitigation value of a coastal ecosystem and use that value to motivate conservation and sustainable use.

10 Literature Cited

- AGEDI. 2014. Blue Carbon in Abu Dhabi - Protecting our Coastal Heritage: The Abu Dhabi Blue Carbon Demonstration Project. AGEDI/EAD. Published by AGEDI. Produced by GRID-Arendal.
- Albert JA, Warren-Rhodes K, Schwarz AJ, Duke, ND. 2012. Mangrove Ecosystem Services & Payments for Blue Carbon in Solomon Islands. The World Fish Center, Solomon Islands. AAS-2012-06.
- Ajonina G, Kairo J, Grimsditch G, Sembres T, Chuyong G, Mibog, DE, Nyambane A and Fitzgerald C. In Press. Assessment of carbon pools and multiple benefits of mangroves in Central Africa for REDD+. UNEP.
- Arnason R, Kelleher K, Willmann R. 2008. The Sunken Billions: The Economic Justification for Fisheries Reform. Section 2.1.3, Value of Intangibles. Joint publication of the World Bank and the FAO.
- Blue Carbon Portal. 2013. The Blue Carbon World, [Online]. Accessed 21 September 2013. Available at: http://bluecarbonportal.org/?page_id=668.
- Bredbenner A. 2013. Profiles in Blue Carbon Field Work. Conservation International, Arlington, Virginia.
- Carbon Dioxide Information Analysis Center. 2013. U.S. Department of Energy, Oak Ridge National Laboratory. 2013 Global Carbon Project, [Online]. Accessed 15 September 2013. Available at: <http://cdiac.ornl.gov/GCP/carbonbudget/2013/>.
- Climate Focus. 2011. Blue Carbon Policy Options Assessment. Climate Focus, Washington, D.C.
- Crooks S. 2014 (February 3). Personal interview.
- De Groot R, Brander L, van der Ploeg S, Costanza R, Bernard F, Braat L, Christie M, Crossman N, Ghermandi A, Hein L, Hussain S, Kumar P, McVittie A, Portela R, Rodriguez LC, ten Brink P, van Beukering P. 2012. Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services* 1: 50-61.
- Donato C, Kauffman J, Murdiyarso D, Kurnianto S, Stidham M, Kanninen M. 2011. Mangroves among the most carbon-rich forests in the tropics. *Nature Geoscience* 4: 293-297.
- Duarte CM, Sintés T, Marbà N. 2013. Assessing the CO₂ capture potential of seagrass restoration projects. *Journal of Applied Ecology* 50 (6): 1341-1349.
- Emmett-Mattox S, Crooks S. 2013. Coastal Blue Carbon as an Incentive for Coastal Conservation, Restoration and Management: A Template for Understanding Options. Brief.
- Field CB, Behrenfeld MJ, Randerson JT, Falkowski P. 1998. Primary production of the biosphere: Integrating terrestrial and oceanic components. *Science* 281: 237-240.
- Fonafifo, Conafor, Ministry of Environment. 2012. Lessons Learned for REDD+ from PES and Conservation Incentive Programs. Examples from Costa Rica, Mexico, and Ecuador.
- Forest Trends and The Katoomba Group. 2010. Payments for Ecosystem Services: Getting Started in Marine and Coastal Ecosystems: A Primer. Forest Trends and The Katoomba Group, Washington, D.C.
- Fourqurean J, Duarte C, Kennedy H, Marba N, Holmer M, Mateo M, Serrano O. 2012. Seagrass ecosystems as a globally significant carbon stock. *Nature Geoscience* 5: 505-509.
- Herr D, Pidgeon E, Laffoley D. (eds.). 2012. Blue Carbon Policy Framework: Based on the discussion of the International Blue Carbon Policy Working Group. IUCN, Gland, Switzerland, and CI, Arlington, USA.
- Gordon D, Murray B, Pendleton L, Victor B. 2011. Financing Options for blue carbon Opportunities and lessons from the REDD+ experience. Nicholas Institute for Environmental Policy Solutions Report. Duke University.
- Grimsditch G. 2011. Options for Blue Carbon within the International Climate Change Framework. *Sustainable Development Law & Policy* 11 (2): 22-24.

- Hutahaean AA. 2012. Blue carbon: A new hope for Indonesia, The Jakarta Post, [Online]. Accessed 28 September 2013. Available at: <http://www.thejakartapost.com/news/2012/08/28/blue-carbon-a-new-hope-indonesia.html>.
- Kauffman JB, Donato DC. 2012 Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests. Working Paper 86. CIFOR, Bogor, Indonesia.
- Intergovernmental Panel on Climate Change. 2013. 2013 Supplement to the 2006 Guidelines for National Greenhouse Gas Inventories: Wetlands (2013 Wetlands Supplement). Intergovernmental Panel on Climate Change, Geneva, Switzerland.
- Irigoiien X, Klevjer TA, Røstad A, Martinez U, Boyra G, Acuña JL, Bode A, Echevarria F, Gonzalez-Gordillo JI, Hernandez-Leon S, Agusti S, Aksnes DL, Duarte CM, Kaartvedt S. 2014. Large mesopelagic fishes biomass and trophic efficiency in the open ocean. *Nature Communications* 5 DOI: 10.1038/ncomms4271.
- International Blue Carbon Initiative. 2012. Guidance for national blue carbon activities: fast-tracking national implementation in developing countries. Brief.
- Lafolley D.d'A. and Grimsditch G (Eds). 2009. The management of natural coastal carbon sinks. IUCN, Gland, Switzerland.
- Laffoley D.d'A., 2013. The management of coastal carbon sinks in Vanuatu: realising the potential. A report to the Government of Vanuatu. Commonwealth Secretariat, London.
- Lau WY. 2013. Beyond carbon: Conceptualizing payments for ecosystem services in blue forests on carbon and other marine and coastal ecosystem Services. *Ocean and Coastal Management* 83: 5-14.
- Lutz MJ, Caldeira K, Dunbar RB, Behrenfeld MJ. 2007. Seasonal rhythms of net primary production and particulate organic carbon flux describe biological pump efficiency in the global ocean. *J Geophys Res* 112: C10011.
- Lutz SJ. 2011. Blue Carbon - First Level Exploration of Blue Carbon in the Arabian Peninsula, with Special Focus on the UAE and Abu Dhabi. A Rapid Feasibility Study. AGEDI/EAD. Published by UNEP/GRID-Arendal, Arendal, Norway.
- Mumby P, Edwards A, Arias-González E, Lindeman K, Blackwell P, Gall A, Gorczynska M, Harborne A, Pescod C, Renken H, Wabnitz C, Llewellyn G. 2004. Mangroves enhance the biomass of coral reef fish communities in the Caribbean. *Letters to Nature. Nature* 427: 533-536.
- Murray BC, Pendleton L, Jenkins WA, Sifleet S. 2011. Green Payments for Blue Carbon: Economic Incentives for Protecting Threatened Coastal Habitats. Nicholas Institute for Environment, Duke University, Durham, North Carolina.
- Murray BC and Vegh T. 2012. Incorporating Blue Carbon as a Mitigation Action under the United Nations Framework Convention on Climate Change: Technical Issues to Address. Report NI R 12-05. Durham, NC: Nicholas Institute for Environmental Policy Solutions, Duke University.
- Murray BC, Watt CE, Cooley DM, Pendleton LH. 2012. Coastal Blue Carbon and the United Nations Framework Convention on Climate Change: Current Status and Future Directions. Policy Brief NI PB 12-01. Nicholas Institute for Environmental Policy Solutions, Duke University.
- Nellemann C, Corcoran E, Duarte CM, Valdés L, De Young C, Fonseca L, Grimsditch G (Eds). 2009. Blue Carbon: The Role of Healthy Oceans in Binding Carbon. A Rapid Response Assessment. United Nations Environment Programme, GRID-Arendal.
- NOAA. 2011. Opportunities to Use Carbon Services to Advance Coastal Habitat Conservation. Report to the NOAA Ocean and Coastal Council (June 17, 2011). Coastal Blue Carbon Team, NOAA.
- Odum EP. 1968. A research challenge: Evaluating the productivity of coastal and estuarine waters. In Keiffner E (Ed), Proc of the 2nd Sea Grant Conference. Univ. of Rhode Island, Kingston.

- Odum WE and Heald EJ. 1972. Trophic analysis of an estuarine mangrove community. *Bull Mar Sci* 22: 671–738.
- Olander L, Galik C, Kissinger G. 2012. Operationalizing REDD+: scope of reduced emissions from deforestation and forest degradation. *Current Opinion in Environmental Sustainability* 4(6): 661–669.
- Overseas Development Institute. Undated. Understanding the social opportunities and risks in forestry and bioenergy carbon offset projects. Infosheet 8, Additionality, non-permanence and leakage. Ford Foundation.
- Pendleton L, Donato DC, Murray BC, Crooks S, Jenkins WA, Sifleet S, Craft C, Fourqurean JW, Kauffman JB, Marbà N, Megonigal P, Pidgeon E, Herr D, Gordon D, Baldera A. 2012. Estimating Global “Blue Carbon” Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems. *PLoS ONE* 7(9).
- Plan Vivo. 2010. Project Idea Note. Mangrove restoration in Gazi bay, Kenya.
- Pershing AJ, Christensen LB, Record NR, Sherwood GD, Stetson PB. 2010. The Impact of Whaling on the Ocean Carbon Cycle: Why Bigger Was Better. *PLoS ONE* 5(8).
- Saba GK and Steinberg DK. 2012. Abundance, Composition, and Sinking Rates of Fish Fecal Pellets in the Santa Barbara Channel. *Scientific Reports* 2(716).
- Samonte G, Karrer L, Orbach M. 2010. People and Oceans. Science and Knowledge Division, Conservation International, Arlington, Virginia, USA.
- Samson M.S., Rollon R.N. 2008. Growth Performance of Planted Mangroves in the Philippines: Revisiting Forest Management Strategies. *Ambio* 37: 234-240.
- Schile L, Kauffman B, Crooks S, Fourqurean J, Megonigal P. In Preparation. Carbon stocks in arid coastal environments. For submission into *Ecosystems*.
- Sifleet S, Pendleton L, Murray B. 2011. State of the Science on Coastal Blue Carbon: A Summary for Policy Makers. Nicholas Institute for the Environment. Duke University, Durham, North Carolina.
- Siikamäki JV, Sanchirico JN, Jardine S, McLaughlin DW, Morris DF. 2012. Blue Carbon: Global Options for Reducing Emissions from the Degradation and Development of Coastal Ecosystems. RFF Report.
- Smith KL Jr., Sherman AD, Shaw TJ, Murray AE, Vernet M, Cefarelli AO. 2010. Carbon export associated with free-drifting icebergs in the Southern Ocean. *Deep-Sea Research II* 58: 1376-1383.
- UNEP. 2004. Seagrass in the South China Sea. UNEP/GEF/SCS Technical Publication No. 3.
- UNEP. 2005. One Planet, Many People: Atlas of Our Changing Environment. Division of Early Warning and Assessment (DEWA), UNEP. Nairobi, Kenya.
- UNEP. 2011. Taking Steps toward Marine and Coastal Ecosystem-Based Management - An Introductory Guide. UNEP Regional Seas Reports and Studies No. 189.
- UNEP-WCMC. 2011. Marine and coastal ecosystem services: Valuation methods and their application. UNEP-WCMC Biodiversity Series No. 33.
- UNFCCC. 2013. Full text of the convention, Article 4: Commitments, [Online]. Accessed 28 September 2013. Available at: http://unfccc.int/essential_background/convention/background/items/1362.php.
- Vistro N. 2010. Manual for Raising Mangrove Container Plants Nurseries and Mangrove Plantation in the United Arab Emirates. Environment Agency Abu Dhabi.
- Waite R, Burke L, Gray E. 2014. Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean. Washington, DC: World Resources Institute.
- Wilmers C, Estes J, Edwards M, Laidre K, Konar B. 2012. Do trophic cascades affect the storage and flux of atmospheric carbon? An analysis of sea otters and kelp forests. *Front Ecol Environ* 10(8): 409-415.

Appendix 1- Example Blue Carbon Project Feasibility Assessment Questionnaire

The following example of a Blue Carbon feasibility assessment questionnaire is adapted from the site selection criteria and intervention elements developed for terrestrial forestry carbon projects. These criteria have been used to help guide the GEF funded Blue Carbon and ecosystem service projects in Ecuador, Indonesia, Madagascar and Mozambique. They have also been shared with partners interested in exploring Blue Carbon projects in Kenya, Malaysia and the Red Sea region.

The following questions are intended to help gauge the potential for project success, develop a baseline for demonstrating additionality, and evidencing the sustainability of activities after project end. They are arranged according to four criteria; appropriateness, technical feasibility, financial feasibility, and risks:

<i>Criterion</i>	<i>#</i>	<i>Sub-criterion</i>	<i>Question</i>
Appropriateness	1	Blue Carbon habitat area	How many hectares does the site cover?
	2	Ecosystem type	What Blue Carbon ecosystem does the site focus on?
	3	Ecosystem health	What is the state of ecosystem? (degraded vs. pristine)
	4	Ecosystem impacts	What are the current impacts and source(s) of degradation?
	5	Ecosystem services	What are the current uses of this resource/area?
	6	Ecosystem services	Are there viable ecosystem service prospects?
	7	Payments for ecosystem services	Do payments for ecosystem services options already exist?
	8	Carbon experience	Do payments for carbon already exist?
	9	Carbon experience	What is the local and national experience with REDD and REDD+ projects?
	10	Replication	What potential does this project have to be replicated?
	11	Project need	Does the site present an opportunity to address key local/national policy challenges?
	12	Project need	How can the project enhance existing management practices?
	13	Livelihood considerations	What is the project's potential to enhance current livelihoods and create new livelihood options?
	14	Legal status	Do local and or national laws enable (or at least not prohibit) payments for carbon and ecosystem services?
Technical feasibility	15	Mapping	Is mapping data available for the project site?
	16	Remote sensing	Do local experts have experience in validating remote sensing data sources?
	17	Scientific capacity	Do local experts have the necessary technical capacity to undertake the project?
	18	Scientific capacity	What are the local/national science needs?
	19	Boundaries	Does the site have defined boundaries?

<u>Criterion</u>	<u>#</u>	<u>Sub-criterion</u>	<u>Question</u>
Technical feasibility	20	Baseline	Is there available data to form a baseline?
	21	Additionality	How can the project help overcome the local baseline?
	22	Partners/stakeholders	Who are the potential local partners?
	23	Partners/stakeholders	Who are the potential national partners?
	24	Users	Who are all the current users of this resource and area?
	25	Local knowledge	Can traditional and or local knowledge play a role in the development and implementation of Blue Carbon policies and management plans?
Financial feasibility	26	Equitable benefit sharing	Does the project area have previous experience in benefit-sharing and how is it perceived by the community?
	27	Market rights	Do prospective ecosystem service and carbon sellers have the necessary legal rights?
	28	Co-finance	What project elements can be covered by project partners as co-finance?
	29	Payments for ecosystem services market	Who are the potential buyers of payments for ecosystem services?
	30	Carbon market	Who are the potential buyers of carbon?
	31	Viability	Is the project expected to be economically viable?
Risks	32	Future development risks	What are the prospects for threats to project outcomes?
	33	Leakage risk	Is there a leakage risk from project implementation?
	34	Local governance/policy	What is the incidence of illegal practices in the area?
	35	Local governance/policy	Are there local institutional conflicts?
	36	Local governance/policy	Are existing marine protected areas functioning?
	37	National governance/policy	Is there national political willingness to support this project or its outcomes?
	38	National governance/policy	Are conservation activities sustained from one administration to the next?
	39	Resource use impacts	Who would be impacted by an implemented Blue Carbon project in terms of current resource access or use patterns?

Appendix 2 - Blue Carbon Resources

Internet resources:

Abu Dhabi Blue Carbon Demonstration Project

<http://abudhabi.bluecarbonportal.org/>

The Blue Carbon Portal

www.bluecarbonportal.org

International Blue Carbon Initiative

www.thebluecarboninitiative.org

NOAA Habitat Conservation - Coastal Blue Carbon

www.habitat.noaa.gov/coastalbluecarbon.html

Blue Carbon Indonesia

www.facebook.com/pages/Blue-Carbon-Indonesia/311239892223268

Blue Ventures - Blue Forests Programme

www.blueventures.org/conservation/blue-forests

Duke University - Coastal Blue Carbon Initiative

<http://nicholasinstitute.duke.edu/initiatives/coastal-blue-carbon>

Bringing Wetlands To Market

<http://wbnerrwetlandscarbon.net>

Sustainable Wetlands Adaptation and Mitigation Program (SWAMP)

<http://www.cifor.org/swamp/home.html>

Blue Carbon Offset Calculator

www.seagrassgrow.org/blue-carbon-offset-calculator

Two Minutes on Oceans with Jim Toomey: Blue Carbon (scroll down for video)

<http://www.rona.unep.org/toomey/>

Forest Trends Marine Ecosystem Services (MARES) Program

www.forest-trends.org/program.php?id=135

Wealth Accounting and the Valuation of Ecosystem Services (WAVES)

www.wavespartnership.org

Natural Capital Project (NatCap)

www.naturalcapitalproject.org

Global Partnership for Oceans

www.globalpartnershipforoceans.org

Further reading:

Blue Carbon, The Role of Healthy Oceans in Binding Carbon (Nellemann et al., 2009)

www.grida.no/files/publications/blue-carbon/BlueCarbon_screen.pdf

The Management of Natural Coastal Carbon Sinks (Lafoley and Grimsditch, 2009)

<http://data.iucn.org/dbtw-wpd/edocs/2009-038.pdf>

- Blue Carbon Policy Framework 2.0* (Herr et al., 2012)
<http://data.iucn.org/dbtw-wpd/edocs/2012-016.pdf>
- Green Payments for Blue Carbon, Economic Incentives for Protecting Threatened Coastal Habitats* (Murray et al., 2011)
<http://nicholasinstitute.duke.edu/sites/default/files/publications/blue-carbon-report-paper.pdf>
- Financing Options for Blue Carbon: Opportunities and Lessons from the REDD+ Experience* (Gordon et al., 2011)
<http://nicholasinstitute.duke.edu/sites/default/files/publications/financing-options-for-blue-carbon-paper.pdf>
- Blue Carbon, Global Options for Reducing Emissions from the Degradation and Development of Coastal Ecosystems* (Siikamäki et al., 2013)
www.rff.org/RFF/Documents/RFF-Rpt-2012-BlueCarbon.pdf
- Mikoko Pamoja Plan Vivo Project Idea Note* (Plan Vivo, 2010)
www.planvivo.org/wp-content/uploads/gazi_pin_PlanVivo_Kenya.pdf
- Blue Carbon - First Level Exploration of Blue Carbon in the Arabian Peninsula, with Special Focus on the UAE and Abu Dhabi: A Rapid Feasibility Assessment* (Lutz, 2011)
www.grida.no/files/publications/bluecarbonabudhabi_lowres-rb.pdf
- The Management of Coastal Carbon Sinks in Vanuatu: Realising the Potential: Scoping and Feasibility Study* (Laffoley, 2013)
<http://thecommonwealth.org/sites/default/files/project/documents/The%20Management%20of%20Coastal%20Carbon%20Sinks%20in%20Vanuatu%20-%20Realising%20the%20Potential.pdf>
- Mangrove Ecosystem Services & Payments for Blue Carbon in Solomon Islands* (Albert et al., 2012)
http://www.worldfishcenter.org/resource_centre/WF_3052.pdf
- Guidance for national blue carbon activities: fast-tracking national implementation in developing countries* (International Blue Carbon Initiative, 2012)
http://thebluecarboninitiative.org/wp-content/uploads/BCPWG_NationalRecs_small.pdf
- Coastal Blue Carbon as an Incentive for Coastal Conservation, Restoration and Management: A Template for Understanding Options* (Emmett-Mattox and Crooks 2013)
www.estuaries.org/images/blue%20carbon%20template_final.pdf
- Opportunities to Use Carbon Services to Advance Coastal Habitat Conservation* (NOAA, 2011)
www.ecosystemcommons.org/sites/default/files/coastal_blue_carbon_report_to_nocc_061311.pdf
- Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests* (Kauffman and Donato, 2012)
www.cifor.org/publications/pdf_files/WPapers/WP86CIFOR.pdf
- 2013 Wetlands Supplement* (IPCC, 2013)
<http://www.ipcc-nggip.iges.or.jp/public/wetlands/>
- Payments for Ecosystem Services: Getting Started in Marine and Coastal Ecosystems: A Primer* (Forest Trends and The Katoomba Group, 2010)
www.forest-trends.org/documents/files/doc_2374.pdf
- Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean* (Waite et al., 2014)
<http://www.wri.org/coastal-capital>

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Back cover image (upper) mangrove deforestation in Madagascar, credit and © Garth Cripps, Blue Ventures, (lower) juvenile fish and mangrove roots, US Virgin Islands, credit and © Christian Perthen (RUI LLC).



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