

Coastal “blue carbon” ecosystems including mangroves, tidal marshes and seagrass meadows are an important part of the global carbon cycle. They provide a wide range of ecosystem services that underpin coastal livelihoods and support adaptation to climate change, including habitat and food chain support for many species of commercial fish, nutrient recycling, shoreline stabilization, storm protection and flood attenuation. These ecosystem services provide a basis for development of interventions that conserve and restore coastal wetlands for climate change mitigation and adaptation.

This document provides knowledge-based guidance for a range of interventions, including policy actions, adjusted management actions or project-based investments that lead to improved coastal wetlands conditions for climate change mitigation and adaptation. Drawing on lessons learned and case studies from coastal wetland management and restoration as well as terrestrial carbon projects, guiding principles are identified. In view of the high potential for inclusion of coastal wetland management in climate change mitigation strategies, consideration is given to including coastal wetland management under existing and evolving mechanisms, such as Reducing Emissions from Deforestation and forest Degradation (REDD+), and Nationally Appropriate Mitigation Actions (NAMAs).

This guidance supports policy makers, coastal management practitioners and civil society organizations in designing projects and activities in coastal wetlands that synergize adaptation and mitigation objectives. Wetland conservation and restoration can be scaled up to establish multiuse functional landscapes integrating community activities in balance with sustaining environmental conditions.

## Guiding principles for delivering coastal wetland carbon projects



RESEARCH  
PROGRAM ON  
Forests, Trees and  
Agroforestry



Fund



# Guiding principles for delivering coastal wetland carbon projects

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# List of abbreviations

AFOLU	Agriculture, Forestry and Other Land Use [VCS project scope]
ALM	Agricultural Land Management [VCS project category]
A/R	Afforestation and Reforestation [CDM project category]
AR	Afforestation and reforestation [standard neutral]
ARR	Afforestation, Reforestation and Revegetation [VCS project category]
CDM	Clean Development Mechanism
CER	Certified Emission Reduction [CDM]
GHG	greenhouse gas
GIS	geographic information system
GPS	global positioning system
IFM	Improved Forest Management [VCS project category]
IPCC	Intergovernmental Panel on Climate Change
LCER	Long-term Certified Emission Reduction
LoA	Letter of Approval [CDM]
MoU	memorandum of understanding
MRV	measurement, reporting, and verification
NGO	non-governmental organization
PD	Project Description [VCS]
PDD	Project Design Document [CDM]
PIN	Project Idea Note
PoA	Programme of Activities [CDM]
PRC	Peatland Rewetting and Conservation
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	REDD, sustainable management of forests and enhancement of forest carbon stocks
tCER	Temporary Certified Emission Reduction
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit [VCS]
WRC	Wetland Restoration and Conservation [VCS project category]

# Preface

With the growing awareness of the role of coastal wetlands in climate change mitigation and adaptation, there are an expanding number project and policy interventions being developed and implemented to conserve and restore these ecosystems. There is a need to share lessons in best practice as activities grow into new territory of large-scale interventions.

This guidance document distils best practice principles for coastal wetland carbon projects, drawing on a long history of project development and implementation in fields of wetlands restoration, terrestrial carbon projects, carbon policy and community engagement. The primary focus is on experience gained in the management of intertidal wetlands, including tidal marshes and mangroves, although many broad lessons can be extended to seagrass meadows. This document is not a manual outlining a step-by-step guide to building or enacting a coastal carbon intervention, as each project will have their own nuances that would challenge such guidance. Here, we provide the overarching

fundamental principles for framing coastal wetland carbon projects and avoiding missteps.

The intended audience of this guidance document are people familiar with carbon project and policy development or wetlands restoration who are seeking an overview of the additional requirements necessary for successful coastal wetland or *blue carbon* interventions.

In the appendix of this guidance document, the reader will find links to some additional key resources on carbon project planning, wetlands management restoration planning, application of the forthcoming Verified Carbon Standard methodology for Wetland Restoration and a manual on standardized field sampling approaches. It is recommended that the reader makes use of those resources and calls upon this guidance to assist in shaping the overall scoping of a potential carbon project. A sister document to follow, funded by Restore America's Estuaries, will illustrate the application of the VCS's methodology for restoration of tidal wetlands and seagrasses.

# Glossary

**Activity data** – According to the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, they are defined as data on the magnitude of human activity resulting in emissions or removals taking place during a given period of time.

**Allochthonous carbon** – Carbon produced in one location, transported and deposited in another.

**Autochthonous carbon** – Carbon produced and deposited in the same location. In the context of blue carbon systems, this type of carbon results from vegetation uptake of CO<sub>2</sub> from the ocean and/or the atmosphere that is converted for use by plant tissues and decomposes into ambient soil.

**Coastal blue carbon** – The carbon stored in tidal wetlands, which includes tidally influenced forests, mangroves, tidal marshes and seagrass meadows, within soil, living biomass and nonliving biomass carbon pools. Coastal blue carbon is a subset of blue carbon that also includes *ocean blue carbon* that represents carbon stored in open ocean carbon pools. (Within this document we use the terms coastal blue carbon and coastal wetlands carbon interchangeably.)

**Blue carbon intervention** – a policy or management activity that results in improved condition of blue carbon stocks (increased CO<sub>2</sub> sequestration or avoided/reduced GHG emissions). Carbon finance projects are one (but not the only) form of blue carbon intervention.

**Carbon pool** – a reservoir of carbon that has the capacity to accumulate or release carbon.

Carbon pools include aboveground biomass, belowground biomass, litter, dead material and soils.

**Coastal rollover** – the landward migration of coastal wetlands with sea-level rise as the landward margin of the wetland expands and the seaward margin erodes.

**Coastal squeeze** – the interruption of coastal rollover by hard infrastructure preventing the landward migration of tidal wetlands while the seaward margin erodes.

**Delta** – a landform that forms through mineral and/or organic sediment deposition at the mouth of a river, where the river flows into an ocean, sea or estuary. Over long periods, this deposition builds the characteristic geographic pattern of a river delta.

**Emissions factor** – the average emission rate of a given GHG for a given source, relative to units of activity.

**Estuary** – a region of a river where freshwater flows meet the sea.

**Geomorphology** – the scientific study of landforms and the historic and contemporary processes that shape them.

**GHG inventory** – an accounting of GHG emitted to, or removed from, the atmosphere over a period of time.

**Landform** – a geomorphological unit, largely defined by its surface form and location in the landscape. Landforms are hierarchical, for example ripples,

channels, wetlands and deltas are all examples of landforms at different spatial scales.

**Mangrove** – a mangrove is a tree, shrub, palm or ground fern, generally exceeding one half meter in height that normally grows above sea level in the intertidal zone of marine coastal environments and estuarine margins.

**Seagrass meadow** – seagrasses are flowering plants belonging to four plant families, in the order Alismatales, which grow in marine, saline environments. There are 12 genera with some 58 species known.

**Soil organic carbon** – the carbon component of soil organic matter. The amount of soil organic matter depends upon soil

texture, drainage, climate, vegetation and historical and current land use.

**Tidal marsh** – a type of marsh that is found along coasts and estuaries, subject to occasional or frequent tidal flooding. Tidal marshes may be classified into freshwater, brackish and saline (salt) marshes.

**Tidal salt marsh** – a vegetated coastal ecosystem in the upper intertidal zone between the land and open saltwater that is regularly flooded by the tides. It is dominated by dense stands of salt-tolerant plants such as herbs, grasses and low shrubs.

**Vegetated tidal wetlands** – lands flooded by occasional or frequent tides supporting mangrove, tidal marsh or sea grass plants.

# Executive summary

## Introduction

Coastal wetlands, particularly tidal marshes, seagrass meadows and tidal forests such as mangroves, store and sequester carbon within biomass and soils. Commonly referred to as coastal “blue carbon” ecosystems because of their relevance for the global carbon cycle, these ecosystems provide climate mitigation benefits and a range of other ecosystem services that underpin coastal livelihoods and support adaptation to climate change. These ecosystem services include habitat and food chain support for many species of commercial fish, nutrient recycling, shoreline stabilization, storm protection and flood attenuation.

Over the past 5000 years, a period of rising sea level, coastal wetlands have developed and migrated with sea level changes, accumulating carbon rich soils in many of the world’s coastal areas. Over the last century or so, large areas of coastal wetlands have been lost as a result of human activities. Looking forward, remaining coastal wetlands are under threat from human resource use, physical alteration and destruction, altered sediment supplies, nutrient and freshwater supply and pollution. At current conversion rates, 30–40% of tidal marshes and seagrasses and nearly 100% of mangroves could be lost in the next 100 years with a social cost to humanity estimated to be between USD 6 and 42 billion annually (Pendleton et al. 2012). As coastal wetlands are destroyed, ecosystem services are lost. Wetlands destruction also leads to CO<sub>2</sub> emissions from oxidization of organic sediments and biomass, which contributes significantly to global warming.

The importance and value of coastal wetland ecosystem services for climate change mitigation and adaptation provides a basis for

development of interventions that conserve and restore these ecosystems. Such interventions may take the form of policy actions, adjusted management actions or project-based investments that lead to improved coastal wetlands conditions. By achieving quantifiable mitigation outcomes, recognizing the value of climate mitigation benefits of wetland carbon management may also generate capital through climate finance mechanisms.

## State of knowledge to support interventions

1. Climate change mitigation frameworks developed for terrestrial ecosystems can be extended to include coastal wetlands (Climate Focus 2011). Mangroves and temperate tidal forests can be the focus of Reduced Emissions from Deforestation and forest Degradation (REDD+) actions, depending upon national definition of forest. Together with mangroves and temperate tidal forests, tidal marshes and seagrass meadows lend themselves to inclusion under Nationally Appropriate Mitigation Actions (NAMAs).
2. The extension of climate change mitigation frameworks for terrestrial ecosystems to include coastal wetland ecosystems requires that we pay attention to some additional considerations. For example, unlike dryland ecosystems, the soil carbon pool of coastal wetlands is often significant. Coastal wetlands are also part of a continuum of ecosystems from the land to the sea and they respond to a wider range of changes in environmental conditions. They sequester some carbon derived from other ecosystems, e.g. by trapping organic matter. Wetlands found in coastal waters at salinities less than half that of seawater produce methane,

which needs to be considered when developing the greenhouse gas (GHG) accounts of an intervention.

3. Sea-level rise will result in an adjustment of the coastal landscape and thus provides a particular challenge in planning blue carbon interventions. In some locations, coastal wetlands will respond resiliently to sea-level rise by keeping pace vertically with sea-level rise or by migrating landward. In other locations wetlands will be lost, especially where landward migration is prevented by human infrastructure or geological features. The drowning of coastal wetlands largely means that ongoing sequestration ceases, and stocks of carbon in aboveground biomass are released while soil carbon stocks in submerged undisturbed soils remain intact. The fate of eroded or disturbed soil carbon remains unclear and depends upon location conditions. The consequences of sea-level rise thus need to be recognized and accounted for when planning and enacting blue carbon interventions.
4. Conservation of existing intact blue carbon ecosystems is technically the simplest and most effective mechanism to manage carbon stocks, and provides the greatest ecosystem benefits. Once a blue carbon ecosystem is destroyed, recovery can be complex due to changes in physical and biological conditions, and presence and need to relocate any infrastructure built across the landscape. Nevertheless, while there are good reasons to prioritize conservation, the benefits of blue carbon ecosystem recovery remain high (and the second best option) especially where restoration can be carried out at landscape scale.

experience exists but has yet to be widely enacted.

2. While blue carbon is a new concept, planning successful conservation and restoration of coastal ecosystems is an established practice with a learning curve of experience spanning over 40 years. Experience has developed at different rates and with different foci around the world but each brings lessons that can be shared as examples of common good practice. This learning encompasses phases of increasing complexity: (1) building wetland conservation and restoration experience and capacity; (2) scaling up to establish multi-use functional landscapes integrating community activities in balance with sustaining environmental conditions; and (3) inclusion of climate change adaptation and mitigation in land-use planning.
3. The technical ability to successfully restore coastal wetland ecosystems today is available on a global level, even if it is not always applied. Recent years have seen increasing interventions to integrate ecosystems within functioning landscapes – ranging from large-scale restoration programs (each tens of thousands of hectares) to village-level integration of mangrove restoration with aquaculture. The challenge is to expand the use of good practice to reduce the rate of project failure, and to include adaptation strategies to sea-level rise and other climate change impacts.
4. To achieve a successful intervention, coastal wetland conservation or restoration should be planned with a landscape response to climate change in mind. Connecting climate change mitigation with adaptation planning will greatly increase the likelihood that blue carbon interventions will be successful.
5. Geomorphic and engineering tools exist to aid in the understanding of how blue carbon ecosystems will respond to sea-level rise, thus supporting project planning and design.
6. Project success is greatly increased if local community engagement and capacity building predates or accompanies the intervention. Examples of good practice exist.

## Lessons from previous projects

1. There are only limited examples of blue carbon ecosystem restoration interventions that account fully for GHG and access carbon markets for finance. Such planning

## Considerations for developing blue carbon interventions

1. Blue carbon policy and management interventions can be deployed in all coastal settings to improve reductions in GHG emissions and removals. However, not all coastal settings will be attractive from a carbon finance perspective because of the cost or complexity of projects and may be more suited to other policy approaches. Potentially, public-private initiatives or stacking credits for multiple ecosystem services may increase project take-up.
2. In preparation for higher rates of sea-level rise there should be consideration of site prioritization, focusing on areas most resilient to sea-level rise.
3. There are no structured templates for enacting blue carbon interventions. General planning frameworks have been developed for carbon projects and for wetlands restoration projects. Good practice can be drawn from both of these frameworks. The following steps, modified from Olander et al. 2011, are appropriate for blue carbon intervention planning:
  - a. define the project concept and perform a preliminary feasibility assessment;
  - b. define a target market or standard;
  - c. establish effective community engagement;
  - d. design the project activities early on;
  - e. assess non-permanence risk and develop mitigation strategies;
  - f. secure project development finance and structure agreements;
  - g. provide for legal due diligence and assess carbon rights;
  - h. provide for a social and environmental impacts assessment and provide a roadmap showing how environmental and social standards can be met;
  - i. maintain ongoing liaison with regulators;
- j. define management roles and responsibilities for project implementation.
4. An early stage feasibility assessment is strongly recommended to set an intervention on the right path, while recognizing technical, legal, financial planning and community engagement considerations.
5. An array of carbon accounting methodologies exists for AFOLU projects that include both biomass and soil organic carbon pools and sources of GHG emissions. Extension of a REDD+ modular methodology including tidal wetlands restoration and conservation is under development. Recognizing the additional requirements for coastal wetland carbon projects, new procedures are proposed under the draft Verified Carbon Standard methodology for Tidal Wetland and Seagrass Restoration. These procedures include: 1) guidance on defining project boundaries in settings subject to mobility with sea-level rise; (2) approaches for developing baseline and project scenarios; and (3) procedures for quantifying *autochthonous* (derived from sequestration on-site) and *allochthonous* (derived from another ecosystem) soil carbon constituents and methane emissions.
6. A particular uncertainty that has not yet been resolved is the fate of carbon that erodes from a tidal marsh with a sea-level rise. For projects involving carbon crediting it is conservative to assume no redistributed carbon is oxidized in the baseline and all redistributed carbon is oxidized in the project case. While further research is required on this topic, in a well-designed conservation or restoration project, the resilience of existing wetlands to a sea-level rise is likely to increase.





# 1

## Introduction

## 1.1 Background

Coastal wetlands are under pressure from land-use changes and a rise in sea level. Yet these important ecosystems are recognized for their values in underpinning coastal health and maintaining and protecting biodiversity, human life and economic resources. Recently, there has been growing awareness that the loss of coastal wetlands is contributing to global warming and that conservation and restoration of these wetlands may help to reduce or possibly reverse some of these impacts. In a global synthesis, Pendleton et al. (2012) estimate that converted and degraded coastal wetlands (including tidal wetlands, mangroves, and seagrass meadows) emit 450 million metric tons (t) of carbon dioxide ( $\text{CO}_2$ ) (range 150 to 1,000 Mt  $\text{CO}_2$ ) annually. Such emissions are equivalent to 3 to 19% of those from deforestation globally and result in economic damages of USD 6 to 42 billion, each year. A number of actions are ongoing to link wetlands management to climate change mitigation responses. In 2014, the Intergovernmental Panel on Climate Change (IPCC) released guidance to nations on procedures for incorporating the human impacts to wetlands within accounting for national GHG emissions and reductions (IPCC 2014). Chapter 4 of that document provides guidance on accounting procedures for: (1) clearance of mangrove forest standing stock;<sup>1</sup> (2) emissions associated with conversion and drainage of coastal wetland soils; (3) the GHG removal potential associated with restoration; and (4) nitrous oxide emissions associated with aquaculture operations.

In parallel, climate mitigation mechanisms and carbon market institutions are exploring the potential to expand their range of activities to recognize wetland management, including coastal wetland management. Coastal wetland ecosystems are commonly referred to as “coastal blue carbon” (or “blue carbon”) ecosystems (UNEP 2009) because of

their relevance to the global carbon cycle and their position in the landscape spanning the transition from terrestrial to near-shore marine settings. The Clean Development Mechanism (CDM) provided the first methodological approach to generate carbon credits from mangrove restoration. In 2011, the Verified Carbon Standard (VCS<sup>2</sup>) recognized a broader range of wetland restoration and conservation activities eligible as potential carbon projects. This was followed by a submission to the VCS in December 2013 of the first global methodology for *Greenhouse Gas Accounting Methods for Tidal Wetland and Sea Grass Restoration* (Emmer et al. 2013). Once approved, this methodology will enable the development of projects across the wide spectrum of coastal blue carbon, including coastal marshes, mangroves, and seagrasses, in addition to the management of drained organic soils. A methodology for the conservation of coastal wetlands is in progress. Early blue carbon project initiatives are underway in many parts of the world, including those enacted under the Livelihoods Fund for Nature in Senegal, West Bengal Sundarbans and Sumatra; and a community mangrove restoration project (Mikoko Pamoja) in Gazi Bay, Kenya. Additional demonstration activities are planned under the UNEP Global Environment Facility Blue Forest Project, in Abu Dhabi, Ecuador, Indonesia, Madagascar and Mozambique.

Coastal wetlands receive increased attention from governments across the globe for their role as a mitigation factor and their importance for climate change adaptation. They mainstream into climate change strategies, action plans, national adaptation plans, national appropriate mitigation actions (NAMAs) and policy frameworks for reducing emissions from deforestation and forest degradation (REDD). This relates to the design phase just as much as to the enabling, ‘readiness’ and the implementation phase.<sup>3</sup> For developing

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1 Recognizing the high carbon density within mangrove wood.

2 [www.v-c-s.org](http://www.v-c-s.org).

3 In a number of climate policy discussions, notably REDD+, the creation of “phases” in the development and implementation has received a lot of attention. The use of “phases” in this chapter

countries, this also means that coastal wetlands can benefit from international climate finance in the short-, mid- and long-term. With this awareness and a growing range of policy frameworks, there is an opportunity to link enhanced management of coastal wetlands, and the associated ecosystem benefits, to climate change policy making at all levels – project, country-level and international.

## 1.2 Objective

At this stage, with respect to both planning and implementation, it is important to show that successful blue carbon intervention is feasible, scalable and provides benefits for the climate as well as for the communities and stakeholders concerned. At the same time, it is worth examining and recognizing the environmental conditions that make coastal wetlands different to terrestrial ecosystems in order to avoid duplication of ill-fitting concepts. We have the unique opportunity to draw together lessons from practitioners in the carbon project development and the coastal wetland conservation and restoration project communities as well as from the international climate policy field.

While the particularities of coastal blue carbon are noted, terrestrial forestry carbon projects and coastal ecosystem conservation and restoration projects have existed independently for some time, and they offer a rich set of experience for future coastal blue carbon work. Forestry carbon projects were first developed in the early 1990s with tree planting programs pioneering certification, and with in-house greenhouse gas verification services by certification companies. The Clean Development Mechanism followed a decade later with its Afforestation and Reforestation (A/R) project category, for which four methodologies have been developed for wetlands and non-wetlands, large-scale and

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may not necessarily be identical with the “phased approach” contemplated for REDD+ in the “Cancun Agreements” (Decision 1/CP.16, paragraph 73) and elsewhere.

small-scale. The VCS, since its launch in 2007, has facilitated projects and methodologies for forest conservation, improved forest management, agricultural land management and wetlands restoration and conservation.

Coastal ecosystem restoration has a long tradition. Early examples of mangrove afforestation or replanting projects, or tidal wetlands revegetation projects can be identified in a number of parts of the world dating back to the 1960s or 1970s. With the development of a no-net-loss policy in the United States, the restoration of coastal wetlands became common practice, gradually scaling up from a few hectares in size to plans and activities encompassing tens of thousands of hectares. In tropical countries, large reforestation mangrove projects have been enacted, with mixed success.

The path to success for carbon projects and for wetlands conservation and restoration projects has included missteps but examples of good practice are now increasingly common. Learning curves and lessons of best practice exist for both carbon projects and coastal wetland conservation and restoration projects. In this guidance we describe the lessons learned and synthesize best practice principles to improve the potential for successful delivery of coastal wetland carbon projects.

## 1.3 Scope of guidance

This guidance draws together experience in carbon project and coastal wetland project development to demonstrate best practice principles in enacting blue carbon interventions. These interventions range from policy activities leading to improved management of coastal resources recognizing climate change mitigation along with other ecosystem service, to projects supported by carbon finance.

Many documents have been written outlining the practice of carbon project development (e.g. Orlander et al. 2011) and for restoring coastal wetlands (e.g. Interagency Workgroup

on Wetland Restoration 2003; SER 2004; USDA 2008; Needleman et al. 2012; Lewis III and Brown 2014). We refer the reader to those texts. Here we summarize best practice principles in key areas of coastal blue carbon interventions in an attempt to help our readers avoid common pitfalls when tackling these or similar challenges, and to offer indicators of risk to delivery of a successful project.

## 1.4 Guidance structure

This guidance document is divided into four main chapters. Guidance on blue carbon project planning and implementation is supported by evidence and lessons for the developers to consider. Relevant case studies encompassing different project types are summarized to demonstrate possible approaches.

Chapter 1 provides the background and scope of this guidance.

Chapter 2 summarizes the current science and policy on blue carbon ecosystems in relation to developing climate change mitigation and adaptation activities.

Chapter 3 draws together lessons learned while engaging in wetlands conservation and restoration practice, carbon project development and from community management.

Chapter 4 outlines considerations for planning blue carbon interventions drawing from established good practice in the fields of carbon project development and ecosystem restoration.



## 2 | The state of knowledge on coastal blue carbon

## 2.1 Coastal wetlands as carbon reservoirs, sources and sinks

Anthropogenic contributions to atmospheric GHG are due largely to the combustion of fossil fuels. However, land-use activities, especially deforestation, are also a major source of GHG emissions, accounting for approximately 8–20% of all global emissions (van der Werf et al. 2011). While the role of terrestrial forests as a source and sink of GHGs is well known, new evidence indicates that another source of GHGs is the release, via land-use conversion, of carbon stored in the biomass and deep sediments of vegetated ecosystems such as tidal marshes, mangroves, and seagrass beds (Crooks et al. 2011, Pendleton et al. 2012). The exact amount of carbon stored by these ecosystems is still an active area of research (Donato et al. 2011; Fourqurean et al. 2013), but the potential contribution to GHGs from their loss is becoming clear. Yet these emissions are so far relatively unappreciated or even neglected in most policies relating to climate change mitigation.

Carbon is stored in vegetated coastal ecosystems throughout the world. Seagrass beds are found from cold polar waters to the tropics. Mangroves are confined to tropical and subtropical areas, while tidal marshes are found in all regions, but most commonly in temperate areas. Combined, these ecosystems cover approximately 49 million ha (Pendleton et al. 2012 and references therein).

The rapid loss of vegetated coastal ecosystems through land-use change has occurred for centuries and has accelerated in recent decades. The causes of habitat conversion vary globally and include conversion to aquaculture, agriculture, forest overexploitation, industrial use, upstream dams, drainage, dredging, eutrophication of overlying waters, urban development and conversion to open water due to accelerated sea-level rise and subsidence. Estimates of cumulative loss over the last 50 to 100 years range from 25–50% of total global area of each type. This decline continues today,

with estimated losses of 0.5–3% annually depending on the ecosystem type, amounting to 8000 km<sup>2</sup> lost each year (Pendleton et al. 2012 and references therein). At current conversion rates, 30–40% of tidal marshes and seagrasses and nearly 100% of mangroves could be lost in the next 100 years.

An emerging body of literature recognizes the importance of coastal habitat loss to climate change (e.g. Duarte 2005; McCloud et al. 2011). However, this research has focused almost exclusively on the lost carbon sequestration potential (annual uptake), while the conversion of large standing carbon pools (previously sequestered and stored carbon) associated with vegetated coastal ecosystems has been overlooked. Only in the most recent studies and reviews has the release of standing carbon pools begun to gain more attention.

Quantitative estimates of these emissions are scarce. Indications are that such ‘pulse’ releases may have the largest and most immediate impact on GHG emissions, possibly amounting to 50 times the annual net carbon sequestration rate (e.g. Lovelock et al. 2012). Similar GHG emissions from the conversion or degradation of freshwater wetlands (e.g. peatlands) are recognized by scientists and international policy-making bodies, while blue carbon remains largely unaccounted for (IPCC 2014). Vegetated coastal ecosystems typically reside over organic-rich sediments that may be several meters deep and effectively ‘lock up’ carbon due to low-oxygen conditions and other factors that inhibit decomposition below the surface (Allen 2000; Johnson et al. 2007; Donato et al. 2011). On a per area basis, these carbon stocks can exceed those of terrestrial ecosystems, including forests, several times over. When coastal habitats are degraded or converted to other land uses, the sediment carbon is destabilized or exposed to oxygen, and subsequent increased microbial activity releases large amounts of GHGs to the atmosphere or water column (Lovelock 2012; Kipkorir et al. 2014). Eventually, the majority of carbon in disturbed coastal ecosystems can be released to the atmosphere (in the form of

$\text{CO}_2$ ,  $\text{CH}_4$  or other carbon species) with the timeframe highly variable and dependent on the specific land use and nature of the sediment.

Pendleton et al. (2012) provided the first global estimates of the emissions associated with disturbance and drainage of blue carbon ecosystems. Combining the best available data on global area, land-use conversion rates, and near-surface carbon stocks in each of the three ecosystems, using an uncertainty-propagation approach, they estimated that 0.45 Pg (billion tons) of  $\text{CO}_2$  (0.15–1.02 Pg) are being released annually, several times higher than previous estimates that account only for lost sequestration. The largest sources of uncertainty in these estimates stem from the limited certitude in global area and rates of land-use conversion, but research is also needed on the fate of ecosystem carbon upon conversion.

Although the relevant science supporting these initial estimates will need to be refined in the coming years, it is clear that policies encouraging the sustainable management of coastal ecosystems could significantly reduce carbon emissions from the land-use sector, in addition to sustaining the well-recognized ecosystem services of coastal habitats.

Rewetting as part of restoration of wetlands may carry issues with  $\text{CH}_4$  emissions. However, at salinities greater than half that of seawater, i.e. 18 ppt,  $\text{CH}_4$  emissions from wetlands are negligible (Poffenberger et al. 2011). Below salinities of 18 ppt,  $\text{CH}_4$  emissions from wetlands may become significant. Dried soils do not emit methane unless standing water is present, such as in ditches (IPCC 2014).

The primary natural sources of  $\text{N}_2\text{O}$  are upland soils under natural vegetation, oceans, coastal waters, riparian zones, estuaries and rivers. The anthropogenic source is associated with the leaching and export from agricultural soils. Agriculture accounts for 67–80% of anthropogenic  $\text{N}_2\text{O}$  emissions, derived from

application of organic and inorganic nitrogen fertilizer and cultivation of legumes that fix atmospheric nitrogen biologically (Ussiri and Lal 2013). Wetting and drying cycles on agricultural soil fosters  $\text{N}_2\text{O}$  production. Other anthropogenic sources include industrial processes, biomass burning and fossil fuel consumption. Available research indicates that wetlands are a negligible source of  $\text{N}_2\text{O}$  (EPA 2010). If wetlands are drained or water tables are lowered, water levels drop, such as through wetland drainage;  $\text{N}_2\text{O}$  may be released either directly as a component of nitrogen release from dried soils or from recycling of anthropogenic nitrogen recycling on the soil medium. The oceans are believed to be one of the largest natural sources of  $\text{N}_2\text{O}$  emissions. Estuaries and rivers contribute  $\text{N}_2\text{O}$  to the atmosphere. However, emissions of  $\text{N}_2\text{O}$  from other aquatic environments are typically classified as anthropogenic because the majority of the nitrogen entering these systems is associated with human activities.

## 2.2 Distribution of intact and drained coastal wetlands

The global extent of coastal wetlands prior to major anthropogenic disturbance represented the long-term accumulation of organic-bearing coastal alluvium throughout the mid to late Holocene; a relatively quiescent period of gradual eustatic sea-level rise (typically 1 mm  $\text{yr}^{-1}$  or less; Gehrels et al. 2011). Gradual sea-level rises over this time fostered conditions favoring the accumulation of deep sequences of organic rich soils, commonly of 3–5 m in depth in some places (Redfield and Rubin, 1962; Allen et al. 2000; Andrews et al. 2000; Drexler et al. 2009; Donato et al. 2011). In locations subject to subsidence, either through soft sediment compaction in deltaic areas or tectonic crustal movement, the contribution of mineral sediment is an important, often critical, component of the wetland building process in the face of enhanced relative sea-level rise. Under conditions of low or negative rates of sea-level rise, coastal wetlands soils consisting predominantly of organic material may be found (Johnson et al. 2007). Their existence is

unbuffered by mineral sediment delivery and is potentially sensitive to accelerated rates of sea-level rise if space is not available for landward migration.

The distribution of mangroves is well mapped. Outside Europe, North America and Australia, the extent of tidal wetlands is poorly documented. The extent of drained coastal wetlands – regions where carbon emissions may be continuing – is less well defined. It is known that the Europeans diked and drained most of their coastal wetlands beginning around the Roman era and continued with real enthusiasm during the seventeenth and eighteenth centuries. This practice spread to the new world with population migration. Between 1850 and the 1960s (when protective legislation was put into place), extensive areas of coastal wetlands along the Atlantic, Pacific and Gulf shores were diked. In states such as California, more than 95% of all coastal wetlands were converted to other land uses.

China also has a long history of diking and drainage, beginning in the late Han Dynasty (202 BC to AD 220). Of the 4.3 million ha of coastal wetlands that existed along the coast of China in 1950, 51% were converted to other land uses by the end of the century (He and Zhang 2001; An et al. 2007). Similar high rates of coastal wetland conversion have spread across Southeast Asia, largely converting coastal wetlands in Thailand and Vietnam and currently spreading rapidly throughout Indonesia.

## 2.3 Response of coastal system to sea level rise and human impacts

A particular consideration in planning and implementing blue carbon projects is how to incorporate the impacts of sea-level rise. Improved management activities on coastal lowlands should recognize the changing nature of the landscape, and that the position of the wetlands and people is likely to change over time with sea-level rise.

Rising sea level results in a spatial shift of coastal geomorphology, manifest through the redistribution of coastal landform comprised of subtidal and intertidal flats, sea grass meadows, tidal marshes and mangroves, shingle banks, sand dunes, cliffs and coastal lowlands (Pethick and Crooks 2000; Abuodha and Woodroffe 2010). This evolution in geomorphology will determine not only the quality and quantity of associated habitats ecosystem services provide, including carbon sequestration, but also the vulnerability of people and infrastructure in the coastal areas. Consequently, effective management of coastal lowlands and their carbon stocks is interwoven with the approach societies take to climate change adaptation. Society has options to build in wetlands conservation and restoration so as to support ecosystem resilience with social resilience within adaptation strategies.

Whatever the rate of sea-level rise, changing energy conditions will demand a response in the distribution of coastal landforms, both big and small. The evolution of the coast in many low-lying areas is hindered by flood protection and coastal erosion defenses, which prevent natural migration of intertidal landform, as a consequence of which these landform and the habitat that they offer, will continue to be lost. Removing barriers to wetland migration or conserving undisturbed wetlands and protecting space for their migration is a way of maintaining functioning coastal wetlands and carbon stocks.

In addition, many coasts are still responding on a large-scale to erosion and redistribution of sediment brought about by engineered loss of tidal floodplains over past decades/centuries and dam construction and reduced sediment loading to rivers. This response, which in some areas will continue for several centuries, will also have to be incorporated into planning of future coastal lowland configurations, including the distribution of conserved and restored coastal wetlands.

## 2.4 Implications for coastal planning

Many coasts are adjusting to two major perturbations: rising sea levels and human disruption to flows and sediment delivery. Coastal “rollover” (the landward migration of coastal landforms) and the redistribution of sediment means that forced stabilization of the coast, the prevention of gradual response to sea-level rise, is often not a management option without ecological and economic consequences (Pethick and Crooks 2000; Doody 2004; Nichols et al. 2007; Stern 2008; Feagin et al. 2010; Krauss et al. 2014). The existence and quality of landforms such as coastal wetlands is dependent upon allowing natural migration. Management interventions to prevent migration will result in degradation of their natural form and degradation of their carbon sequestration capacity. Maintaining fixed flood defenses will, with rising sea levels, undoubtedly result in the loss of intertidal wetlands, unless policies for landward retreat of flood defenses and re-flooding of drained wetland areas to restore wetlands and provide capacity for wetland migration are enacted.

The management of sea-level rise will have to be undertaken at the landscape scale,<sup>4</sup> seeking to accommodate natural coastal migration while recognizing the impacts of relocating infrastructure on wider coastal processes. If coastal resources are to be managed in a more sustainable manner, mechanisms must be found that accommodate the pressures of past and current engineering activities and the pressures of ongoing sea-level rise. To do so will require integrated strategic planning, linking river catchments, estuary/deltaic and coastal management to prevent development in vulnerable coastal areas, to minimize disruption to environmental processes, and where possible, to restore coastal functions and habitats to offset losses resulting from development and sea-level rise.

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<sup>4</sup> The scale at which regional environmental processes operate. This may be at the catchment scale or the delta/estuary wide scale, for instance.

## 2.5 Importance of conserving intact wetlands

Conservation of intact wetlands is the most effective management to minimize detrimental change in GHG emissions and to protect existing ecosystem services. Coastal wetlands sequester carbon slowly over time, building stocks of soil carbon that may be thousands of years old, below a cover of living biomass. These stocks of carbon are protected emissions, as long as neither the sediments nor soil moisture conditions (determined by regional hydrology) are impacted. Destructive clearing of cover and exposure of wetland soils to desiccation and aeration results in rapid release of soil carbon stocks. Emissions from drained organic soils continues until either the management practice is changed or the stock is exhausted. By conserving intact wetlands, direct impacts to carbon stocks are minimized and resilient responses to sea-level rise are enhanced.

## 2.6 Policy opportunities and new mechanisms for carbon management

The turn toward blue carbon is a fairly recent development, facilitated by the growing sensibility for the policy relevance of Reducing Emissions from Deforestation and forest Degradation (REDD+)<sup>5</sup>, on the one hand, and the successful negotiation by a handful of countries of a peat carbon agenda, on the other. Indeed, both forests and peatlands include relevant blue carbon elements; most of the world’s mangrove species represent forest vegetation types,<sup>6</sup> and many wetlands

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<sup>5</sup> The “+” indicates the elements of sustainable management of forests and enhancement of forest carbon stocks.

<sup>6</sup> They also meet the thresholds in canopy cover and height in order to be considered ‘forest’ under the UNFCCC Clean Development Mechanism (CDM), cf. the definition of Decision 16/CMP.1, paragraph 1 (a): “Forest” is a minimum area of land of 0.05-1.0 hectare with tree crown cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all

are naturally forested (by mangroves or other trees) and thus fall into the category of forest land; peatlands are a wetland key category.

Thus, a blue carbon milestone was achieved in 2011, when the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) established “wetland drainage and rewetting” (WDR) as an eligible activity under Article 3 (4) of the Protocol, permitting parties with an inscribed quantitative emission limitation and reduction objective (QUELRO) to account for all sinks and emissions from any wetlands (as long as they have been drained and/or rewetted after 1990). The new WDR accounting framework does not give rise to investment in blue carbon projects, but it is seen as an important step towards the integration of wetlands in the future mitigation architecture and the to-be-built climate finance mechanisms (von Unger 2014). In a technical dimension, the recently adopted *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands and the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement)* will enable countries to adequately implement WDR accounting, if they choose to do so.

While the particular formats of future climate finance mechanisms are yet to be defined – the topic is one of the more contentious issues in international negotiations; discussions are led around the agenda items of nationally appropriate mitigation actions (NAMAs), a new market mechanism (NMM), a framework for various approaches (FVA), and of a REDD+ mechanism – there is growing consensus on a number of points. First, it is likely that countries in their current negotiations leading to the Paris-COP will agree that blue carbon as a whole (or that at least certain blue carbon

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plantations which have yet to reach a crown density of 10-30 per cent or tree height of 2-5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest.”

categories) will be covered by a *comprehensive accounting and crediting framework* under the UNFCCC; second, these credits will be expressed in *tons of CO<sub>2</sub>eq*; and third, they will serve as the basis for *results-based funding and transactions*.

In the emerging field of NAMAs and REDD+, blue carbon already plays a prominent role,<sup>7</sup> and coastal wetlands benefit greatly from REDD and/or NAMA *readiness* activities.<sup>8</sup> The enhancement of *strong nature protection institutions*, the build-up of a *transparent land inventory* and of *clear land tenure allocations*, and the *policy mainstreaming* of sustainable forest and wetland management into a wide range of laws and policies lays the groundwork for successful blue carbon interventions.

It should be noted that an important type of blue carbon – mangrove forests – has been recognised under Kyoto’s climate finance mechanisms, namely the CDM.<sup>9</sup> But this

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7 See, for instance, Grimsditch, G., Mangrove Forests and REDD+ (February 2011), [http://www.un-redd.org/Newsletter16/Mangrove\\_Forests\\_and\\_RED/51394/Default.aspx](http://www.un-redd.org/Newsletter16/Mangrove_Forests_and_RED/51394/Default.aspx); King, L., Notes from the Field. Including mangrove forests in REDD+ (December 2012), <http://cdkn.org/wp-content/uploads/2012/12/Notes-from-the-field-Lesley-King-1.pdf>; for country examples see the Vietnamese pilot project on mangroves and REDD+: Mangroves and markets: supporting mangrove protection in Ca Mau Province (2012), <http://thereddesk.org/countries/initiatives/mangroves-and-markets-supporting-mangrove-protection-ca-mau-province-vietnam>; see also the case of Indonesia, which has launched a REDD+ and peatland campaign together with the Government of Norway, cf Letter of Intent between the Government of the Kingdom of Norway and the Government of the Republic of Indonesia on “Cooperation on reducing greenhouse gas emissions from deforestation and forest degradation”, [http://www.regjeringen.no/upload/SMK/Vedlegg/2010/Indonesia\\_avtale.pdf](http://www.regjeringen.no/upload/SMK/Vedlegg/2010/Indonesia_avtale.pdf), and which sees both the NAMA and the REDD+ approach as inclusive of a range of land-based emissions, cf. Republic of Indonesia, Indonesia’s Framework for Nationally Appropriate Mitigation Actions (November 2013), [http://www.paklim.org/wp-content/uploads/downloads/2013/12/Indonesias-Framework-for-NAMAs\\_2013.pdf](http://www.paklim.org/wp-content/uploads/downloads/2013/12/Indonesias-Framework-for-NAMAs_2013.pdf).

8 For the linkage between REDD+ finance and blue carbon finance see Gorden, D./Murray, B.C./Pendleton, L./Victor, B., Financing Options for Blue Carbon. Opportunities and Lessons from the REDD+ Experience (2011).

9 <http://cdm.unfccc.int/methodologies/DB/CKSXP4981AC1QHXZPEVRJXQKZ3G5WQ>.

recognition was limited to afforestation and reforestation (A/R) interventions, excluding conservation activities, and it came with the liability of generating only temporary carbon credits, so called temporary certified emission reductions (“tCERs”) and long-term certified emission reductions (“lCERs”).<sup>10</sup> As a result, the number of mangrove interventions under the CDM has remained small.<sup>11</sup> It is too early to say what role, if any, the CDM will have in the climate regime currently under negotiation and meant to be in place by 2020. The discussions at the level of the Conference of the Parties to the UNFCCC (COP) show, however, a growing number of countries which are dissatisfied with the concept of temporary credits and which are willing to contemplate alternative choices to deal with the issue of permanence in sequestration projects.<sup>12</sup>

The difficult position of blue carbon under Kyoto was compensated to some extent by a more adaptive and stronger performing voluntary carbon market. Since its launch in 2007, in the land-use category (AFOLU), the VCS has approved more than 15 methodologies and a myriad of modules for specific accounting procedures,<sup>13</sup> as well as more than 80 individual projects.<sup>14</sup> Among approved methodologies and methodologies under validation there are four peatland related ones (three for tropical regions and one for temperate climates) and one tidal wetland methodology for Louisiana.<sup>15</sup> The American Carbon Registry (ACR) recently approved a wetlands restoration methodology for the Mississippi Delta.<sup>16</sup>

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10 Decision 5/CMP.1, Annex, paragraph 1 (g) and (h).

11 The only registered project so far is Project 5265 (“*Oceanium mangrove restoration project*”), <http://cdm.unfccc.int/Projects/DB/ErnstYoung1316795310.61/view>.

12 See the country submissions to the UNFCCC of Chile, Colombia, Indonesia, and Nepal accessible under UNFCCC, [https://unfccc.int/documentation/submissions\\_from\\_parties/items/8017.php](https://unfccc.int/documentation/submissions_from_parties/items/8017.php): *Land use, land-use change and forestry under Article 3, paragraphs 3 and 4 of the Kyoto Protocol and under the clean development mechanism*.

13 <http://www.v-c-s.org/methodologies/find-a-methodology?title=&tid=14>.

14 <https://vcsprojectdatabase2.apx.com/myModule/Interactive.asp?Tab=Projects&a=1&t=1>.

15 [www.vcsprojectdatabase.org](http://www.vcsprojectdatabase.org)

16 <http://americancarbonregistry.org/carbon-accounting/restoration-of-degraded-deltaic-wetlands-of-the-mississippi-delta>.





### 3 | Lessons learned from previous projects



In this section we summarize lessons learned from previous projects in the fields of coastal wetland conservation and restoration, AFOLU carbon project development and engagement with communities. We begin with a summary of a learning curve which tracks growing knowledge related to management of coastal systems from disconnected activities to progressive integration incorporating climate change adaptation and mitigation.

### 3.1 The learning curve in coastal wetlands management

A learning curve of experience has been built up over time through the practice of conserving and restoring coastal wetlands and the parallel development of carbon projects. Progress along this learning curve is not evenly distributed around the globe but the lessons learned are broadly transferable.

The starting point (stage 0) reflects the recognition that coastal wetlands holds value and that projects or programs should be developed to improve environmental conditions. Progress to more advanced stages on the learning curve is enhanced by a combination of national /state level policy development and local community engagement. Advancement may be made in the absence of one of these but progress will be slow.

For coastal wetlands conservation and restoration, the following learning stages in management best practice can be recognized:

- 1. Building basic wetlands conservation and restoration capacity.** This involves the sharing and developing of practical experience and knowledge, delivery of projects and establishment of institutional capacity. At this level, success or failure is typically assessed at the individual

project level, with a limited consideration of interactions between projects.

- 2. Establishing a multiuse functional landscape.** Scaling projects to a meaningful level that meets ecological requirements and provides sustainable livelihoods for local communities requires a greater degree of planning and capacity than found at stage 1. Multiuse landscapes require advanced levels of awareness and social capacity with enforceable agreements about land-use arrangements, development of market enterprise (e.g. sustainable aquaculture) and technical capacity to meet needs such as land-use planning and provision of flood protection.
- 3. Inclusion of climate change in land-use planning.** The highest stage in coastal wetland conservation and restoration capacity is inclusion of mechanisms to meet the challenges of climate change. For coastal wetlands and populations on coastal lowlands this is dominantly driven by the threat of rising sea levels, particularly in settings with infrastructure. Tackling the challenges in coastal settings requires capacity to develop forward looking plans, supported by technical capacity for evaluating scenarios and/or approaches for adapting to change. Management for sea-level rise requires a shift in philosophy for many, from land-use planning involving static boundaries to recognizing the challenges of moving boundaries.

Stage 3 is the critical stage required to enact a resilient response to climate change in coastal settings and only in recent years has it become part of the consciousness of the planning community.

Box 1 provides examples of the developing learning experience in example estuaries of San Francisco Bay and Tampa Bay in the United States.

## Box 1. Case studies from the United States for incorporating climate change resilience into habitat restoration

Over the past several decades, coastal wetland restoration projects in the United States have grown from small, individual restoration actions, to large, regionally coordinated actions totaling tens of thousands of hectares. While early projects were driven by regulatory requirements to mitigate for wetlands lost to land-use conversion, later projects were enacted to recover lost ecosystem services. Restoration projects today are generally more complex, larger in size, balance multiple objectives, based upon science, and have greater stakeholder involvement. The 1990s and early 2000s saw major advances in regional ecosystem restoration planning. Climate change, though often acknowledged in these early regional plans, typically did not factor prominently in planning decisions.

Over the past 5 to 10 years, planning for climate change has received more attention in the United States, with several estuaries in the process of updating regional restoration plans for climate change, or having recently completed such updates. Planning frameworks, predictive modeling tools, implementation approaches and policies for incorporating climate change are changing rapidly. They exist in inconsistent states of development that vary by project, by region and by implementing agency. Two examples of major regional restoration efforts and how they are incorporating the effects of climate change are described below.

### San Francisco Bay

The San Francisco Bay Estuary is the largest on the west coast of North and South America, with its biological significance recently recognized as a "Wetland of International Importance" under the Ramsar Convention. The estuary has also suffered some of the most extensive degradation of any estuary in the United States, with conversion of more than 95% of intertidal wetland areas to other uses. The 1980s and 1990s saw restoration work being undertaken by diverse entities, including public agencies, NGOs, landowners, corporate interests and citizen volunteers.

By the mid-1990s, it became clear that restoration efforts would benefit from a more coordinated approach with a common vision. The Baylands Ecosystem Habitat Goals (Goals Project) was undertaken in 1995 to establish a long-term vision for sustaining diverse and healthy communities of fish and wildlife resources in the San Francisco Bay Area. The Goals Project report (1999) set a bold vision for restoring 40,500 ha (100,000 acres) of tidal wetlands and related habitats around the bay. The report provides recommendations for the kinds, amounts and distribution of wetlands and related habitats. It represents the work of more than 100 scientists, resource managers and other participants. The project provided the scientific foundation that has resulted in 5260 ha (13,000 acres) of restored habitat, with an additional 16,200 ha (40,000 acres) acquired and at various stages of restoration planning.

In recognition of the significant effects that climate change is projected to have on bay habitats, a technical update to the Goals Project is currently underway. Begun in 2012, the Technical Update will assess the predicted impacts of climate change on Baylands and recommend adaptation strategies. The Technical Update uses a science-based approach to consider how climate change will influence the evolution of Baylands' habitats, the interface between the Baylands and the Bay, the transition zone between Baylands and uplands, wildlife populations and carbon accounting. Scientists and managers from the region are developing the content of the update, similar to the process for the original Goals Project report, with oversight from a steering committee of environmental management and regulatory agencies and an independent science review panel.

In addition to the Goals Project, other efforts have been taken to improve wetland ecosystem sustainability with climate change. The Long Term Management Strategy for the placement of dredged material in the San Francisco Bay region, which for many years has encouraged the beneficial reuse of dredged material for wetland construction, is exploring ways of further

**Box 1. Continued**

facilitating reuse in light of increased bay sediment needs from climate change, and sea-level rise in particular. The San Francisco Bay Joint Venture has taken steps to link dredging projects with wetland restoration projects (to date, 7 million m<sup>3</sup> of dredged material reused to build wetlands). Additionally, the Subtidal Goals Project (2010) is increasing regional awareness of the role of submerged habitats – mud flats and shoals, eelgrass, oyster and seaweed beds – in a “whole shoreline” approach to climate change adaptation.

## Tampa Bay Estuary

Tampa Bay is a 103,100 ha estuary along the Gulf of Mexico in Florida and has been designated as an estuary of national significance. Tampa Bay is one of the few estuaries in the United States that contains all three primary blue carbon habitats: salt marshes, mangroves and sea grass beds. Historically, the coastal environment of Tampa Bay was degraded by conversion of intertidal wetlands and poor water quality. Between 1950 and 1990, sea grass beds declined by over 50% and emergent tidal wetlands by almost 21%.

In response to a declining environment, actions have been taken to improve water quality and to conserve and restore tidal wetlands. A consequence of improved water quality has been recovery of sea grass coverage, estimated at 13,312 ha – 52% higher than that mapped in 1982. There has also been an increase of 175 ha (433 acres) of tidal wetlands between 1995 and 2007, an increase of 2%.

Like other parts of the United States, intertidal habitat restoration in the Tampa Bay area has evolved from small (<0.2 ha; <0.5 acre), single-species marsh plantings to regional planning for large (>400 ha, >1000 acres) projects that restore multiple species and habitat types (Cross 2014). Regional restoration planning completed in 1996 with adoption of the *Tampa Bay Habitat Master Plan* in 1996, which set restoration and protection goals for critical coastal habitats such as sea grass, mangroves and salt marshes, using a ‘restore the balance’ approach (Lewis and Robison 1996). This approach, supported by the scientific community, recognized that it was not possible to regain previous extents of habitat in Tampa Bay and recommended that estuarine habitats be restored in a similar ratio to what existed in the 1950s prior to extensive development in the watershed.

The *TBEP’s 2010 Habitat Master Plan Update* (Robison 2010) identifies climate change and sea-level rise as potentially major habitat threats and recommends monitoring to measure associated habitat changes.

In a 2014 assessment of Tampa Bay as a case study for incorporating climate change resiliency into habitat planning and protection (Cross 2014), TBEP notes that current habitat management strategies may need to be adapted to consider the impacts of climate change and continued development within the watershed. In particular, the ‘restore the balance’ approach may no longer be feasible, especially if climate change is moving Tampa Bay towards a mangrove-dominated system. Scientists at TBEP used models to visually determine how a sea-level rise of 2 m may impact coastal habitats in the Tampa Bay region. Outcomes from this assessment are being incorporated into adaptive management strategies to balance habitat conservation and restoration with sea-level rise adaptation planning. In addition, the White House Administration is supporting blue carbon planning, linking adaptation and mitigation actions, for this estuary, as a priority initiative to demonstrate natural system resilience to climate change.<sup>1</sup>

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<sup>1</sup> [http://www.estuaries.org/images/policy/enhancing\\_climate\\_resilience\\_of\\_americas\\_natural\\_resources.pdf](http://www.estuaries.org/images/policy/enhancing_climate_resilience_of_americas_natural_resources.pdf)

## 3.2 Broad lessons in wetlands conservation and restoration planning

A number of lessons have been learned by practitioners in conservation and restoration that form recommendations for best practice. Some of these lessons are not specific to wetlands but are worth including here, as they are important considerations for wetland projects. Overall, thoughtful planning can improve project outcomes and reduce costs. With climate change, and particularly sea-level rise, we need to think beyond planning for individual projects to evaluation of environmental trade-offs across the landscape.

### 3.2.1 Have a clear and coherent project planning approach

Successful conservation and restoration is most likely when a project: has a coherent planning process that identifies goal and objectives, opportunities and constraints; adopts the best available conceptual models; and sets performance metrics to track project performance relative to achievable success criteria.

### 3.2.2 Plan conservation and restoration projects in the wider landscape context

When planning to conserve and restore coastal habitat, planners should take the largest possible view of landscape processes. Maintaining and restoring expansive connected areas, rather than a patchwork of isolated projects, improves the ecological outcome of conservation and restoration projects. Providing space creates resilience to gradual change and the capacity to respond to disturbance events, such as extreme storm events. Landscapes mosaics also offer a degree of ecosystem redundancy, which is critical to maintaining resilient populations of species. This provides capacity for carbon projects to respond resiliently to dynamic change.

In urbanized settings, which do not offer large-scale restoration potential, strategic location

of a conservation and restoration project can make the most of space available to maximize ecosystem benefits. Creation of a fringe of wetlands can help attenuate nutrients leaching from adjacent lands. Sited at key staging locations, wetlands may provide corridors or refuge for migrating fish or birds. Equally, a strategic location of wetlands can complement carbon management, providing a gradient as wetlands respond to climate change.

Not incorporating the landscape context will probably limit the cumulative performance of conservation and restoration projects over time. Opportunistic, *ad hoc* selection of project sites is likely to offer limited project success. Only strategic, spatially explicit project planning that incorporates landscape-scale processes is likely to create a synergistic and complimentary cumulative response (Simenstad et al. 2006).

### 3.2.3 Prioritize to enhance sustainability

Not all coastal areas will respond resiliently to climate change and sea-level rise. Given scarce resources, coastal planners may need to prioritize conservation and restoration activities. At higher rates and magnitudes of climate change, many existing coastal ecosystems may cease to respond resiliently; habitats may evolve to other habitat types (e.g. vegetated wetlands to mud flats). Planners should begin preparing now for potential higher degrees of climate change by taking the following precautions and actions:

- Locate projects in a way that accounts for landscape evolution and target locations that will be sustainable under potential future conditions.
- When planning for adaptation and mitigation, seek to: (1) reduce project exposure; (2) reduce *sensitivity* to events and long-term changes, and (3) increase resilience of coastal habitats and the built environment to pressures of long-term climate change and infrequent high magnitude shocks and stresses (e.g. *El Niño* events, large storms, brown marsh events, etc.) (Tompkins and Adger 2004).

- Adaptation planning, with conservation and restoration, should seek to increase the capacity of all coastal systems to respond resiliently to climate change, but particular focus of effort may be warranted at sites that could become an ecosystem refugium should greater rates of climate change occur.
- Provide protection to areas upslope and adjacent to coastal areas that would provide future coastal wetlands as they migrate with sea-level rise.
- Manage sediment as a resource (for instance, estuaries, and wetland areas that naturally receive high sediment loading in the catchment may be the most resilient to sea-level rise, though some may appear unlikely candidates under current conditions.)
- Do not squander sediments dredged from channels; reuse them within an estuary or within an appropriate coastal area. Reduce offshore disposal of dredged sediments.
- Recognize that the configuration or quality of modern landscapes may prevent historic ecosystems from being restored and other beneficial habitats types may be preferable.

### 3.2.4 Restore physical processes and ecosystem dynamics

Natural processes and dynamics underlie a coastal ecosystems' delivery of environmental goods and services. Natural adjustments in the structure and composition of coastal ecosystems result from natural environmental fluctuations and disturbance dynamics. Attempting to control these natural processes (e.g. using levees and culverts) will result in a fragile, degraded ecosystem that will not respond resiliently to climate change and require ongoing maintenance.

### 3.2.5 Recognize the value of project design and engineering

Investing in design and engineering work is sometimes seen as an unnecessary expense. However, an appropriate level of engineering design can lower risk, save construction costs, increase certainty in project outcome, reduce the need for adaptive management or post-

project remediation, and greatly improve the ecological value of the restored habitat. Given that land acquisition costs are often the largest financial burden to a restoration project, there is a positive benefit/cost ratio to restoring a higher quality habitat per unit area of land. The success of the project will be judged on its outcomes, which in turn will influence future public support and funding.

Understanding the geomorphology of the coastal setting will inform the project planner about the elements of the project that will evolve naturally and those which will require project actions. When including a restoration element, the project design should be based on a suitable site 'template', establishing natural processes that drive the evolution towards a desired outcome. It is generally an oversimplification to believe that passive actions will result in full restoration of coastal functions. Some wetland restorations are easier than others. Technical complexity is reduced if:

- the site has experienced neither deep subsidence nor fill placement;
- the natural sediment supply necessary to raise surface elevations is plentiful;
- vegetation propagules are abundant;
- remnant channel drainage systems exist on-site;
- site modifications (borrow pits, drainage channels, infrastructure) are minimal;
- internal wave climate is acceptable;
- invasive species are not prevalent within the region;
- planners have learned lessons from prior restoration activities at the site;
- there are no external constraints (confined channels; sediment budget issues, water quality issues; erosion or flood risks to adjacent lands, etc.).

It is occasionally possible to just breach a sea wall and restore a fully-functioning tidal wetland. Typically, some level of planning and design is required either to provide cost-effective environmental enhancements (e.g. initial channels and transitional ecotones). In urbanized settings, flood management

requirements and other concerns can constrain a restoration project.

Planning complexity can increase when restoring large areas, though very attractive beneficial ecological and socioeconomic economies of scale may result. In estuaries with a limited sediment supply, large-scale restoration can impact the sediment budget of the whole estuary, disturbing tidal flow patterns and impacting patterns of sedimentation and erosion (Orr et al. 2003).

### 3.2.6 Understand the restoration trajectory and ecological thresholds

History has demonstrated a high potential for success when restoring minimally disturbed habitats or landscapes. The potential for success is poor when attempting to recreate habitats from scratch (e.g. planting mud flats that have not supported mangroves previously). The greater the disturbance, the greater the time frame and extent of intervention required to rehabilitate the landscape.

Human activities may also leave an ecological and geomorphic legacy that is difficult or impossible to override through restoration. Built infrastructure in an environment places constraints on any restoration project.

Ecological and geomorphic thresholds are perhaps the most difficult aspects of habitat restoration to accurately predict, but do exist. While thresholds may be an issue within a restoration site, they are usually a greater concern at the wider and longer-term level, especially when the system hosting the restoration project is already under stress. Examples of significant thresholds in coastal areas include salt marsh shifting to open mud flats due to sediment starvation.

Difficulties arise when accommodating thresholds into restoration planning because: (1) empirical datasets are small; (2) causes and effects may not manifest themselves

for many decades after the environmental change; and (3) deterministic, process-based models (e.g. sediment transport simulations) are poor at recognizing environmental thresholds. Nevertheless, historic analysis and field observations have demonstrated the presence of thresholds. Practitioners need to assess whether critical thresholds will impact the sustainability of their project and plan accordingly to reduce risks.

We must consider our restoration projects in the context of the wider landscape. Does the landscape show evidence of approaching an environmental threshold? Will our restoration project reduce or increase the probability that that threshold will be crossed? Is the new state of the system desirable or undesirable? Will active long-term maintenance be required to maintain the coastal system and restoration project in the preferred state? Should we site the restoration project in a more resilient coastal setting?

Geomorphic and ecological environmental indicators may provide evidence that a system is changing and approaching a system threshold. A system-wide growth of a mud flat area within a salt marsh complex (e.g. sustained increase in a pan area or channel area) may indicate that sediment supply and vegetation growth is unable to keep pace with sea-level rise. Similarly, sustained thinning of beaches on a barrier island complex may be an indication of increasing risk of barrier loss and impending conversion to open coast.

### 3.2.7 Conserve and restore blue carbon ecosystems sooner rather than later

The magnitude of climate change impact is likely to increase over time. Intact wetlands will respond most resiliently to climate change. For restoration projects, the amount of time since restoration is directly proportional to the likelihood of a resilient response to climate change. A strategy of restoring coastal ecosystems sooner rather than later would improve coasts resiliency to climate change.

With the rate of sea-level rise likely to accelerate towards the middle of this century, project proponents have a window of opportunity to restore coastal ecosystems in the short-term. Restoring a system to a level of maturity both reduces ecosystem sensitivity and enhances resilience to future climate change. For example, the restoration of salt marsh and mangroves typically progresses, via the build-up of sediment, from newly created mud flats to a vegetated marsh. Once the wetland attains a suitable elevation, vegetation establishes, accompanied by the inclusion of organics as part of the marsh accumulation processes. The presence of vegetation increases resilience to a sea-level rise by enabling more rapid accumulation of soils. In addition, the binding of soils by root mats reduces the marsh's sensitivity to wave attack associated with offshore deeper water.

### 3.2.8 Restoration of historic conditions is not always possible

In many cases, past human-induced changes have resulted in a highly altered landscape – with changes to ground elevations, hydrology, native species available for colonization and many other factors. A landscape that has adjusted and incorporated the human environment may lose its capacity to be restored to historic conditions. Moreover, climate change and ongoing nonnative species invasions are leading to community assemblages with a mix of species that historically did not coincide.

Restoration should plan for the future. Where restoration of resilient historic conditions is feasible, historic conditions can provide a positive and clear restoration target, particularly to support endemic species. Where restoration of resilient historic conditions is not feasible, restoration should seek to optimize benefits, recognizing that past conditions are no longer attainable.

### 3.2.9 Be patient

Ecosystem restoration takes time. Depending on the extent of environmental disturbance, a system may take decades to fully recover. Planners must understand the restoration

trajectory and track its progress while recognizing that time frames of natural processes do not conform to human time constraints.

The time element is important for carbon project development. Some projects might be considered instantaneous, such as wetland protection and avoided emissions. Others may take a number of years or even decades before vegetation and carbon sequestration is reestablished.

### 3.2.10 Avoid transplantation of non-indigenous and nuisance species

Numerous examples exist of invasive species, diseases and pests being introduced as part of coastal management activities. Levels of awareness are now much higher, but care should always be taken to minimize risks.

### 3.2.11 Specific lessons in tidal wetlands restoration planning and design

The most resilient restored wetland is one that is integrated to support wider ecosystem health or integrity, which may be described by ecologists as:

*Conditions in which a system realizes its inherent potential, maintains stable conditions, preserves its capacity for self-repair when perturbed, and needs minimal support for management (Karr 1993).<sup>17</sup>*

The design of a tidal wetland is one component of a complete restoration activity that starts with the development of *restoration goals and objectives* and proceeds through planning, design, construction implementation, monitoring and management (PWA and Faber 2004). Design decisions are determined by the set of goals and objectives adopted for the project and the planning methodology used.

<sup>17</sup> Indicators for assessing human impact on wetland integrity are provided by Brouwer et al. (1998), recognizing the need to distinguish between impacts to structural, compositional and functional system components across landscape, water regime and biodiversity wetland attributes.

Early restoration projects did not clearly articulate intent (goals and objectives), nor was an explicit planning methodology described or followed. A typical statement for early restoration in San Francisco Bay might be:

*to create a successful tidal wetland habitat from mudflat to mature pickleweed marsh plain as rapidly as possible.*

This statement captures an imperative to achieve a set of wetland functions associated with mature vegetated marsh as quickly as possible. As restoration projects have matured, there has been a growing realization that there can be a substantial trade-off between extent and cost of site grading and rate of evolution of vegetated wetlands (PWA and Faber 2004). The value of creating a template from which a wetland restoration evolves is now better understood; during this process associated ecosystem attributes coevolve to restore a complete wetland.

Early wetland restoration projects typically included the following ecological objectives:

- to achieve rapid evolution to a vegetated wetland habitat;
- to provide appropriate habitat to support a particular species.

Restoration planning is more commonly integrated into multi-objective projects that more fully integrate ecological and social objectives that:

- allow for the evolution of ecologically rich and diverse wetland habitat;
- promote the evolution of complex tidal drainage systems, particularly to support invertebrates, fish, birds and vegetation.
- maximize the contribution to the wider coastal system with connectivity between the wetland, where possible;
- create a complete wetland that includes a mosaic of elements including transitional areas with terrestrial habitat.
- provide for public access (sometime treated as a constraint)
- provide for habitat response and migration with sea-level rise;
- reduce flood hazards.

A rigorous planning methodology requires that these objectives are made operational by defining measurable indicators to track performance in achieving them. These indicators provide metrics for comparing alternative restoration plans, the outcome of the selected plan and the basis for monitoring and adaptive management. They also provide us with the ability to compare expected outcomes with actual performance, improving experience in restoration design and giving us the opportunity to develop and to share advances along the learning curve. In many early restoration projects, performance indicators were either poorly defined, or specified as unrealistic regulatory compliance criteria, such as a percentage of vegetation of a particular species within a rapid time frame.

Every potential restoration project will have its own set of constraints. Often the most significant constraints arises from human infrastructure such as levees, buildings, pipes, landfills, property boundaries, roads and access requirements. These constraints often define the ‘footprint’ of which activities can be undertaken and the degree of connectivity with other habitat elements. Typical restoration constraints might include:

- maintenance of flood management or erosion protection for adjacent properties;
- preservation of public access (may be an opportunity);
- maintenance of access to utility corridors;
- prevention of colonization by invasive species;
- pest control;
- a need to minimize impacts to other habitats (e.g. conversion of one habitat to another for the project)

The evolution of knowledge in articulating and addressing the opportunities and constraints of restoration planning directly inform planning for coastal carbon projects. Carbon activities are an additional layer of interest, which are additive to the planning process but cannot ignore the other requirements in developing a successful restoration plan.

### 3.3 Lessons from carbon project development

Considerable expertise and technical knowledge has been built up over the years that can serve current and future blue carbon initiatives. However, while many projects reached completion and have often proved perfectly resilient long after the intervention took place, many other initiatives have never moved beyond the design or test phase, or have stopped at some point during implementation. The reasons are numerous and not always related to the decrease in carbon prices that has been witnessed in recent years. Sometimes, project proponents found out (too late) that certain requirements of carbon standards were not met. Sometimes necessary seed financing was not in place. Sometimes land access and control could not be secured (and maintained). Sometimes the political context was not favorable, and sometimes a project suffered from a lack of 'ownership' by the project developers. In many cases, the development of a dedicated carbon project served as a secondary goal and only received minimal attention when the project was too far along in the design and implementation process to make necessary amendments. Unfortunately, factors that lead to the failure or deferral of carbon projects are not usually shared with the public or other project developers and therefore newcomers will often not benefit from lessons learned.

What most of the failed or troubled projects have in common is that the proponents did not make the right prioritizations from the start. Land-use and coastal-use related projects touch upon a multitude of sensitive issues – methodology and monitoring being only one amongst many others. A comprehensive analysis combining technical, financial and legal issues and preparing the intervention in practical terms should precede the concrete planning and implementation phase in any project. A feasibility and prioritization assessment will minimize and mitigate the risks and will, if well designed, serve as a robust script to go ahead with the project.

From experience with carbon projects since the 1990s, we have extracted recommendations in five different areas of blue carbon project development:

#### 3.3.1 Assume ownership of the project

A general point in project management and implementation, 'project ownership' is often lacking, when it comes to not-for-profit AFOLU projects. A project may well bring together a range of different actors, stakeholders, consultants, interested third parties etc., but there must be a functional project lead entity, which oversees all incidents of project development and identifies with the results.

#### 3.3.2 Choose and demarcate the site(s) carefully

Careful site selection is probably the most obvious activity and yet it is too often badly managed. In many cases there is only a vague description of sites or "pools of sites", and a proper assessment of suitability does not happen, undermining the longevity of the project and the permanence of emission reductions. Apart from the fact that detailed demarcation is a strict necessity of project validation, site selection must be oriented at a number of factors, including the level of exposure to degradation risks, the carbon output, tenure rights and permits, viability of access and control, risk of non-permanence, projected costs, and viability of action.

#### 3.3.3 Choose the standard and the project delivery cycle

In many cases, a proper test of the most suitable standard is not made. The coexistence of various standards—on the regulated and voluntary markets—is an opportunity for projects to identify the most appropriate solution. But while the availability of a methodology is an obvious advantage, it is not necessarily a determining factor. A range of standards is open to the use of a methodology developed elsewhere. The particularities of the project delivery cycle—validation, registration, State approvals, verification and certification—

and the market (price and liquidity) factor are relevant considerations. And so is the question of whether or not double certification (creating a premium through the combination with biodiversity and/or social benefits) is worth the transaction costs.

### 3.3.4 Access the market early

Most land-use based carbon projects have not been part of the regulated carbon markets—the European Emissions Trading Scheme, the CDM and Joint Implementation—and so the substantial carbon price depression in those markets has so far had little impact on prices in this market segment.<sup>18</sup> For most projects, however, the land-use based carbon market remains a non-liquid boutique with few interfaces with stronger markets (California's plans to open its regulated scheme for some international forest credits and South Africa's willingness to allow international VCS credits into the envisaged tax-or-offset scheme are noticeable examples.) Sellers and (mostly voluntary, corporate and social responsibility-driven) buyers have to identify each other and negotiate project features and prices on a case-by-case basis. This means that project proponents should explore market opportunities early in the process and in different venues, both public and private. The novelty of 'blue carbon' may help in the process of attracting buyers.

### 3.3.5 Link the project to other (climate) finance options

Project proponents often have little knowledge of the full range of support schemes. Public international climate finance, in particular, has become a massively important financing tool—developed countries are under the obligation to provide USD 10 billion additional funding ("fast-start") to developing countries annually under the 2009 Copenhagen Accord and

the 2010 Cancun Agreements. Domestically available funding of developed countries (for projects within the developed world) easily exceeds this sum. Carbon credits can represent important performance indicators to trigger public funds, and project proponents should seek to combine various funding streams.

### 3.3.6 Check the costs and prepare for economies of scale

Transaction costs incurred from carbon cycles, market participation and consulting and legal fees can add considerable amounts to the project costs. Such costs may be recoverable, however, through international (public) donors. Notably, carbon standards often come with the option to upscale intervention throughout a country or even beyond. A set of smaller initiatives may be designed and managed as a grouped project, providing opportunities for a gradual roll-out and flexibility in timing of validation. Size will lower relative costs, and project proponents should always consider whether economies of scale can be activated. Close cooperation between the different initiatives is also a key to lowering costs so that capacity can be shared and mistakes avoided. On the flip side, however, scaling up can present its own issues, such as when the initial developer lacks the capacity to operate the project on a much larger scale.

Blue carbon is still a fairly new field, but there is plenty of experience with land-use based carbon project development from which blue carbon pioneers can learn. A decent feasibility and priority assessment is the key to success. Above are assembled a number of core considerations that such an assessment should be built on. An example of a blue carbon project supported by carbon credits is that of Makoko Pamoja in Kenya (Box 2).

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18 Forest Trends' Ecosystem Marketplace & Bloomberg New Energy Finance, 2013 - [www.ecosystemmarketplace.com](http://www.ecosystemmarketplace.com).

## Box 2. Mikoko Pamoja – Conservation and management of mangrove forest in Kenya for community benefits through carbon credits

Mikoko Pamoja is a community-led carbon finance project for the conservation, management and restoration of 117 ha of mangroves in the south coast of Kenya at Gazi Bay.

The project is organized by the Kenya Marine Fisheries Institute (KMFRI), Napier Edinburgh University and Earthwatch Institute, with credits managed by Plan Vivo.<sup>1</sup> The project is supported by the village community, consisting largely of fishers whose livelihoods are connected to the health of the mangrove, with whom there is a clear payments arrangement for sold carbon credits. Part of the payments covers dedicated staff time for the project, with the remaining funds being allocated to community projects and additional mangrove activities overseen by village leaders.

The objectives of the project are to: (1) facilitate community development in the Gazi Bay area by using funds raised from the sale of Plan Vivo Certificates for projects of collective benefits agreed by the local people; (2) to restore degraded and denuded mangrove ecosystems in Gazi Bay through community policing of illegal mangrove harvesting and the application of local expertise in the planting of mangrove seedlings; (3) to enhance carbon sequestration and other ecosystem services including improved fisheries, wildlife habitats and coastal protection; (4) to promote sustainable mangrove related income, such as beekeeping and ecotourism; and (5) to act as a demonstration project showing feasibility and desirability of community-led mangrove conservation with carbon credit funding and thus influence national and regional policy.

The 615 ha of mangroves in Gazi Bay belong, like all mangrove forests in Kenya to the national

government. The mangrove forest has been exploited for many years by individuals and groups for building poles and fuelwood.

As of late 2014, the project sold the 2013/14 Planvivo certificates of 3000 t CO<sub>2</sub>. The price of the credit varied from between USD 6.50 for its first offering to USD 10.00 this year. Credits are sold only for the mangrove biomass and with the bulk of soil carbon not unaccounted for.

The success of the project stems from the following: (1) strong community support for the project; (2) well established and ongoing scientific research on the mangroves of the region; (3) knowledgeable government agencies interested in partnering with the local community on the project; (4) a supportive national policy that promotes participatory forest management; and (5) a central individual, Prof. James Kairo, a mangrove scientist with KMFRI, and a long-term resident of Gazi village who serves as connection between all interests.

One of strengths of the project is the approach taken to reduce illegal harvesting of mangroves and leakage by including the cultivation of fast-growing terrestrial forest plantations to serve as alternative wood sources. The project has also established mangrove ecotourism – an informational boardwalk managed by the Gazi women for recreation and school educational activities. Recently, the project partnered with World Wide Fund for Nature (WWF) to promote energy saving stoves and solar lights that would further reduce community dependency on mangrove forests for wood. An assessment of site response to sea level rise is not incorporated into the project. However, the gradually sloping landscape will provide a suitable environment for mangroves to respond resiliently to sea level rise, should the current available space for landward migration be protected.

1 Project documents can be found at: <http://www.planvivo.org/projects/registeredprojects/mikoko-pamoja-kenya/>

## 3.4 Lessons learned from community engagement

Community engagement is a fundamental requirement of successful coastal or carbon project. Effective community engagement is, at its core, an educational process. There are some key principles which form the foundation of effective community education, leading to an empowered citizenry better able to resolve local issues, adapt to change, manage coastal systems and engage with professional stakeholders; such as government agents and academics.

### 3.4.1 Bottom-up approaches

The approach discussed here, at its heart, is a learner-centered approach. Its goal is to build skills, knowledge and experience of coastal communities to the point where they feel empowered to continue to adapt and make positive changes in their communities. The development of critical thinking skills is crucial in this process, and the results are measured in terms of changes in not only skills and knowledge, but also motivation and behavior.

There are numerous entry points around coastal wetlands that can be selected to engage a community, and habitat restoration is one. Undertaking assessments together, participating in training courses, creating restoration designs, appraising designs, developing monitoring plans, implementing restoration and monitoring the results are all critical steps to create a level playing field for community members and more formal stakeholders from government and academia.

The process of coastal wetland restoration takes time, and while communities are waiting for results, especially in developing nations, it is important to be involved in something with more immediate returns. Sustainable livelihood programs and enterprise development that run concurrently with habitat restoration may fit the bill. This may involve improved production practices, the

exploration of alternative livelihoods, post-harvest processing of coastal commodities, cooperative formation, participatory market analysis, bookkeeping and business planning.

Extensionists play a critical role in bottom-up coastal wetland restoration and livelihoods development. Extensionists from a variety of disciplines such as forestry, fisheries, aquaculture and agriculture should all be considered for capacity building through training, and involvement in program facilitation. Other sectors may also have extension services, such as social agencies, disaster preparedness agencies, cooperative development or small and medium enterprise development agencies. All will benefit from capacity building on participatory processes.

A vast array of participatory extension tools and curriculum exist. Some recommended approaches include Coastal Field Schools ([www.rcl.or.id](http://www.rcl.or.id), Box 3), Ecological Mangrove Rehabilitation ([www.mangroverestoration.com](http://www.mangroverestoration.com); Lewis 2005, Lewis 2009 and Lewis and Brown 2014; Box 4) or Forest Management Learning Groups ([www.recoftc.org](http://www.recoftc.org)).

As community members become experts at various hands-on aspects of coastal wetland management, individuals need to be identified and prepared to engage formal sector stakeholders in policy level decision-making processes.

### 3.4.2 Top-down approaches

As grass-roots community empowerment is taking place, government needs to be engaged along a trio of pathways.

- 1. National support:** A thorough understanding of national policy and programs related to coastal wetland restoration, carbon finance, climate change and adaptation, etc., needs to be developed. Opportunities should be sought from the onset to legitimize and support both the approach and the ultimate outcomes of the project at the national level. Although much work will take place subnationally,



### Box 3. Adaptive capacity enhancement through participation in coastal field schools

Participation in field schools helps to build capacity within village communities who are learning to develop more sustainable livelihoods and adapt to climate change.

Participants in saltwater-tolerant rice field schools learned valuable skills at a field day. Through the field school, farmland that had been disused for years or even decades due to saltwater intrusion again became productive. Participants learned to hybridize local strains of rice for saltwater tolerance, along with organic, low external input rice-growing techniques.

Measuring pneumatophores (breathing roots of mangroves) of *Sonneratia* spp. allows communities to track sea-level rise over time, as the pneumatophores grow up to the highest atmospheric tide. This data helps the community plan for a variety of adaptation actions.

The community of Kurricaddi in South Sulawesi restored 75% of a pond complex owned by the University of Muhammadiyah (UNISMUH) **using Ecological Mangrove Rehabilitation (EMR)** techniques learned in an **EMR Field School**. Strategic breaching of the dike walls and creation of tidal creeks restores a natural tidal hydrology, while hand distribution of propagules assists in natural regeneration of mangroves.

Participants in fish-farmer schools measured turbidity in a pond after application of organic fertilizer. The remaining 25% of the pond complex was managed for polyculture of shrimp, milkfish and *Gracilaria* seaweed using organic methods. UNISMUH is using the entire 25 ha area as a natural laboratory for studies on mangrove and aquaculture, with a high degree of local community involvement. (Brown and Fadillah, 2013)

Photos by Ben Brown, Blue Forests

## Box 4. The development of ecological mangrove rehabilitation in Indonesia

The principles of Ecological Mangrove Rehabilitation (EMR) were developed in Florida, United States by practitioners who rehabilitated a variety of degraded mangrove forest types (Lewis 2005, Lewis 2009 and Lewis and Brown 2014). The method calls for a trio of assessments (ecological, hydrological and disturbance of natural revegetation) to take place in both a degraded area intended for restoration as well as a nearby reference forest. Assessments are followed by the development of a rehabilitation design intended to remove disturbances to mangrove colonization and growth, which, once implemented result in a self-regulating mangrove system resembling the value of a natural mangrove system. EMR was first applied in Indonesia in 2003, in a 20 ha abandoned shrimp pond in North Sulawesi.<sup>1</sup> Hydrological rehabilitation was undertaken in partnership with the local fishing community using hand tools to strategically breach shrimp pond dike walls and fill artificial channels. Ten years later, 21 species of mangroves have recolonized the area, with an average density of over 8000 trees per hectare and a canopy height of over 12 m. (Brown et al. 2014) The same method has recently been applied at a larger scale in 480 ha of disused shrimp ponds on Tanakeke Island, South Sulawesi, resulting in the natural recruitment of over 2200 ha within 3 years of restoration.<sup>2</sup> Both of these projects relied on local labor and the use of hand tools, with a restoration cost of between USD 1000 per hectare including project management.

Recently, trials using heavy machinery have been run in South Sulawesi, in order to gauge the cost of larger-scale restoration, which local stakeholders and government have requested in mangrove-aquaculture landscapes ranging in size from 7500–60,000 ha in Sulawesi and Kalimantan. Studies on carbon sequestration and storage, biodiversity enhancement and substrate

elevation are currently being run in partnership with local and international universities at each site, in order to better evaluate the overall impact of rehabilitation.<sup>3</sup> Future analysis will include measurements of GHG fluxes (CO<sub>2</sub>, CH<sub>4</sub> and potentially N<sub>2</sub>O) from existing ponds.

As communities wait for the mangroves to grow, they are engaged in livelihood programs revolving around sustainable fisheries, forestry and coastal agriculture. Empowered community members take part in multi-stakeholder mangrove management working groups supported by the Ministry of Forestry as part of the development of an adaptive collaborative management system, to ensure the long-term protection and sustainable use of the mangroves as they mature.

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1 Mangrove Action Project – Indonesia and University of Sam Ratulangi

2 Restoring Coastal Livelihoods Project – Mangrove Action Project – Indonesia, CIDA and Oxfam.

3 Charles Darwin University – Research Institute for Environment and Livelihoods, National University of Singapore, University of Hassanuddin and Blue Forests.

national-level support helps motivate subnational stakeholders, and provides pathways for scaling-up of best practices and positive outcomes.

2. **Subnational support:** At the provincial (state), district and sub-district levels, contacts can be established and relationships developed with a variety of agencies that will be interested in supporting outcomes such as coastal wetlands restoration, enhancement of coastal community welfare, gender equity, poverty alleviation, fisheries enhancement, adaptation to sea-level rise, coastal food security, etc. Working together to achieve these objectives builds leverage for future advocacy, especially around the adoption of practices that led to these outcomes (such as ecological restoration, field schools for improved livelihood development or forest management learning groups for improved community involvement in coastal resource management). As trust is built at this level, government agents often allocate financial support or make project partners aware of government programs that can continue to leverage mutually desired outcomes.

3. **Capacity building for extensionists:** Extensionists not only play crucial roles in facilitating field-based initiatives, but also in reporting back to government to gain support for initiatives and acting as a conduit between the community and the government. Training of trainers programs should involve not only government extensionists, but community facilitators, and even university students interested in extension, in order to build a cadre of facilitators for up-scaling and sustainability of the effort. In many parts of the developing world, agricultural extension through programs like Farmer Field School (which has reached 10-20 million farmer participants world-wide since the 1990s) is quite well developed, whereas their counterparts in fisheries and forestry are much less familiar with participatory,

learner-centered processes, relying more on provision of prepackaged technical solutions. Cross-training should be considered, allowing experienced agricultural trainers to influence their counterparts in fisheries and forestry, as well as extensionists from nascent agencies such as Climate Change and Disaster Risk Reduction who will also benefit from the use of participatory processes.

### 3.4.3 Meeting in the middle

Coastal resource management problems are by nature complex, requiring both a thorough understanding of their root causes and an interdisciplinary approach to their resolution. Multi-stakeholder, interdisciplinary boards are essential in order to manage such systems, which exist in the overlap between the jurisdictions of many agencies, and require equal input by coastal communities, especially women, to develop a long-term functioning management approach. The nature of coastal wetlands issues spreads beyond the intertidal zone or estuary, sometimes requiring a whole watershed approach, meaning a higher level of complexity and stakeholder involvement. Academic institutions are essential members of such a multi-stakeholder board or working group, assisting with provision of scientific information and methods, the design of tests to probe the management system (see Adaptive Collaborative Management below), and in the monitoring and evaluation of the system. Likewise, members of the business community have a place on such boards, as stakeholders that impact upon the resource and benefit from the provision of goods and ecosystem services.

### 3.4.4 Adaptive collaborative management

Adaptive co-management is an approach to governing a system such as coastal-wetland, with eyes to socioeconomic and ecological aspects of the system. Adaptive management focuses on gaining a better understanding of a focal system, by developing hypotheses and tests to probe the system in order to uncover unknown aspects of the system. The results

of these tests are used to build a dynamic model of the system. The tests are carried out periodically over time (in an iterative manner) ever informing management decisions. In this way, adaptive management is an ongoing learning process. By engaging in adaptive management as a collaborative effort, different stakeholder interests and inputs are considered, and stakeholders develop the capacity to think more critically, and to prescribe management solutions based on newly derived knowledge. Given the background of climate change and sea-level rise, the development of a management system and the capacities of managers to think and work adaptively, is essential.

Key features of adaptive co-management include ([www.resalliance.org](http://www.resalliance.org)):

- a focus on learning-by-doing;
- synthesis of different knowledge systems;
- collaboration and power-sharing among community, regional and national levels;
- management flexibility.

Other important themes in adaptive co-management include: improving evaluation of process and outcomes, additional emphasis on power, the role of social capital, and meaningful interactions and trust building as the basis for governance in social-ecological systems.

### 3.4.5 Innovative incentive mechanisms vs. normative budgeting and planning processes

There are a number of innovative incentive mechanisms being used to promote coastal wetland restoration, conservation and sustainable utilization. These mechanisms, over time have grown beyond the confines of their original focus, evidenced by the development of REDD+, which encompasses a broader range of social, economic and ecological benefits than the “original” REDD. Most of these “additional” considerations are simply reiterated goals of sustainable development interventions from previous decades. There is also an increasing

importance attached to ensuring grass-roots community engagement in these incentive mechanisms, evidenced as a case-in-point by a slew of reports on equitable benefit-sharing in carbon projects. In some ways, these innovations are viewed as “*ad-hoc*” policies, although, to be fair, they are certainly evolving along with a deeper understanding of urgent global issues such as GHG emission, sea-level rise and climate change.

While the fairness of the “*ad-hoc*” label can be debated, it must be remembered that governments have pre-existing, “normative” planning and budgeting processes for short-, medium- and long-term programs developed to address a similar set of issues. Tapping into these processes, to achieve outcomes both old (poverty alleviation, sustainable livelihoods, food security and gender equity) and new (carbon sequestration, adaptation to SLR and climate change mitigation, etc.) issues can ensure a greater degree of permanence for adoption of program approaches and delivery of outcomes.

As detailed above, this is best achieved when bottom-up and top-down approaches are coordinated to eventually meet in the middle. A bottom-up approach to accessing and influencing normative planning and budgeting processes would take place after a set of restoration, livelihood and improved coastal resource management initiatives have taken place. Empowered community members would become engaged in a process to learn how government budgeting and planning takes place at the local level, moving up the chain of command for approval at a higher level of government, and tracking the return of a short- or medium-term plan in the form of financial and programmatic support packages. Communities can undertake role-playing activities, and be engaged in mock planning processes, before taking part in actual planning processes where they can advocate for favored approaches to wetland restoration, sustainable coastal resource utilization and small enterprise development, etc. Several communities’ members can be involved as

watchdogs of the process, to ensure that demands at the community level are not lost as they move through the command chain.

At the same time, higher levels of government can be engaged, to show how programs such as coastal wetland rehabilitation can help them achieve multiple high-level objectives (e.g. carbon sequestration and storage, forest conservation, poverty alleviation, etc.). When governments learn that communities are engaged in future thinking activities, such as scenario development, adaptation to climate

change, etc., allocations for favored processes can be made in the medium (5-year) and longer term (20-year) government plans.

Finally, when meeting in the middle, an institution such as a multi-stakeholder mangrove management working group, can access support for mutual objectives by both innovative incentive mechanisms (REDD+, PES, Aquaculture Certification) as well as “normative” mid- and long-term government planning and budgeting processes.



## 4 | Planning a blue carbon project

Chapter 4 describes a blue carbon project approach drawing from established guidelines for development of land-use carbon projects. The discussion assumes a general familiarity with land-use carbon project development and focuses on describing how considerations are different for blue carbon projects.

We do not intend to give a comprehensive overview of available carbon standards and procedural carbon project development, or to deliver an operational wetland restoration project manual.<sup>19</sup> There are a number of well-researched guidance documents available on the subject of land-use carbon projects (e.g. Olander et al. 2011) and wetland restoration (e.g. Interagency Workgroup on Wetland Restoration 2003; Society for Ecological Restoration 2004; Lewis and Brown 2014), which we recommend to the interested reader.

There are currently no structured templates for enacting blue carbon interventions but general planning frameworks have been developed for carbon projects and wetlands restoration projects. Furthermore, good practice can be drawn from both of these frameworks. The steps in Box 5 are appropriate for blue carbon intervention planning.

While the planning process is presented as a sequence of steps, in actuality the process is iterative, with multiple steps proceeding in parallel.

## 4.1 Project concept

The first step in project development is for the project proponent to define the project goals and objectives, basic project activities, and the location of the project. The spectrum of blue carbon activities include *conservation* (avoiding the release of GHGs to the atmosphere) and *restoration/creation* (establishment of CO<sub>2</sub> uptake from the atmosphere and/or reduction in CH<sub>4</sub> emissions). That means a blue carbon project can protect the wetland ecosystem against degradation (e.g. caused by the removal of vegetation or the loss and/or oxidation of wetland soil carbon) or sequester carbon by creating carbon sinks in the form of a growing vegetation (e.g. by restoring a mangrove forest, tidal marsh or seagrass vegetation), by enhancing carbon storage in soils and sediments (e.g. by inducing plant litter production and creating the necessary hydrological conditions), or by reinstating salinity conditions to reduce CH<sub>4</sub> emissions.

## Box 5. Steps in blue carbon project planning

1. Define the project concept and perform a preliminary feasibility assessment
2. Define a target market and select a carbon standard
3. Establish effective community engagement
4. Design the project activities
5. Assess nonpermanence risk and develop mitigation strategies
6. Secure project development finance and structure agreements
7. Provide for legal due diligence and assess carbon rights
8. Provide for a social and environmental impacts assessment and provide a road map of how environmental and social standards can be met
9. Maintain ongoing liaison with regulators.

Source: modified from Olander et al. 2011.

<sup>19</sup> A practitioner's guide to the application of the forthcoming VCS *Methodology for Tidal Wetland and Seagrasses Restoration* is currently in preparation (Emmer et al. In press)

Restoration on organic soils halts or reduces emissions from drained soils, in addition to any gained carbon sequestration.

Examples of blue carbon activities include:

- **Conservation/Avoided emissions**
  - Protection of at risk coastal wetland ecosystems (including direct displacement, modifications to hydrology and sediment supply), re-wetting drained peatlands, sediment recharge on drowning coastal wetlands, creation of accommodation space (removal of barriers) for wetlands migrating with sea-level rise.
- **Restoration and creation of coastal wetlands** – Breach of levees and reconnecting tides, raising soil surface with dredged material, increasing sediment supply by removing dams, restoring salinity conditions (reducing CH<sub>4</sub> emissions), improving water quality for sea grass benefits and planting/revegetation.

In general, coastal wetlands restoration projects can require a greater level of effort compared to typical AFOLU projects due to the types and scale of project activities. Unlike a forestry project, for example, where project activities may consist primarily of planting trees, coastal wetland projects may have substantial activities associated with grading, removal of infrastructure and building of new infrastructure to avoid flooding of adjacent lands. More substantial project activities and the need for flood management can necessitate greater need for engineering and analysis, impact assessment bringing additional project benefits (ecosystem services and flood risk reduction). In addition, as discussed in Section 3, coastal projects must take into account sea-level rise and a restoration trajectory with dynamic physical and biological processes acting upon the site. Because of these additional costs, some blue carbon interventions may not be viable based solely upon payments for carbon credits but may require stacking of credits or support from agencies with broader objectives. These project differences are discussed in

the subsections below, along with ways of addressing them.

## 4.2 Preliminary feasibility assessment

A preliminary feasibility assessment, using readily available information, enables the project proponent to screen and narrow the range of alternatives or identify fatal barriers to progress. A preliminary feasibility assessment is an initial consideration of all steps in blue carbon project planning that are described in the subsections below. If the selected alternative(s) are considered to be potentially feasible, then it is recommended to continue to a full feasibility assessment involving detailed analysis.

## 4.3 Select a carbon standard and methodology

GHG accounting methodologies, under the various standards outline procedures for quantifying the GHG benefits of a project and provide guidance for determining project boundaries, setting baselines, assessing permanence and ultimately quantifying the GHG emissions that were reduced or GHGs removed from the atmosphere.

It is important to select an appropriate carbon standard and methodology from the onset. For wetlands, a decision should be made as to whether the soil carbon pool is an important component of the project. Additional considerations are the need to account for CH<sub>4</sub> and N<sub>2</sub>O fluxes as well as changes in carbon storage, the connectivity of the wetland within the wider landscape and how this influences accounting for carbon movement, and accounting for the impacts of climate change, particularly sea-level rise on these parameters. All these elements influence the selection of the methodologies available.

The entire spectrum of blue carbon project activities has been captured by one of the leading voluntary market carbon standards, the VCS. Incorporating both restoration and

conservation, the VCS, under its AFOLU Requirements<sup>20</sup>, includes five project categories *viz.* Afforestation, Reforestation and Revegetation (ARR), Improved Forest Management (IFM), Avoided Conversion of Grasslands and Shrublands (ACoGS), Reducing Emissions from Deforestation and forest Degradation (REDD) and Wetlands Restoration and Conservation (WRC). Under WRC, two more categories are recognized, i.e. Restoring Wetlands Ecosystems (RWE) and Conservation of Intact Wetlands (CTW). Not surprisingly, most blue carbon projects will be combinations of two or more of these categories. For example, a mangrove forest, including its soil, may be protected against degradation while already degraded parts of it will be restored. Such an intervention would combine elements of REDD, ARR and WRC into a REDD+ activity.<sup>21</sup> Other examples are given in Appendix B. Considerations in selecting and applying a methodology for a blue carbon project are described below.

#### 4.3.1 Project proponent(s)

To varying extents, carbon standards require the identification of one or more ‘project proponents’. While the CDM allows for more loosely-defined “project participants,” the VCS comes with firm requirements on substance for the project proponent and targets the identification of the “individual or organisation that has overall control and responsibility for the project, or an individual or organisation that together with others, each of which [being] also a project proponent, has overall control or responsibility for the project”<sup>22</sup>.

The relatively high threshold for project proponents is of particular relevance in blue carbon related projects, which are by their nature often multi-objective and involve multiple partners. The underlying rational is twofold: First, clear project ownership structures help facilitate project development and implementation. Where it proves impossible to allocate control in one actor/organization or collectively in several actors/organizations, project management as a whole is at risk from the start. Second, the project proponent is the natural rights-holder for the carbon asset. In case there is a mismatch between the official proponent and the true holder of project control, the generic claim to the carbon asset may become contentious.

Proponents and other stakeholders (including the carbon buyer, in case a project is meant to generate carbon credits) must create governance and corporate structures that are best suited for the particular operational, legal and financial needs.

#### 4.3.2 GHG accounting methodologies

An array of GHG accounting methodologies for AFOLU project activities exists that include both the biomass and the soil organic carbon as major carbon pools and sources of GHG emissions. Current methodologies relevant for blue carbon projects are listed in Appendix B. Under the VCS – the as of yet only carbon standard seriously covering wetlands – forestry or agriculture-based project activities occurring on wetlands must adhere to both the respective project category requirements (ARR, IFM, REDD) and the WRC requirements, unless the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is not significant. For REDD methodologies we refer to the *Project Developer’s Guidebook to VCS REDD Methodologies*,<sup>23</sup> noting

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20 See [www.v-c-s.org/program-documents](http://www.v-c-s.org/program-documents)

21 While not recognized as a project category, under the VCS REDD+ is an eligible term to express the combination of REDD and other project activities involving sustainable management and stock enhancement.

22 VCS Project Definitions, version 3.5 (October 2013), at <http://www.v-c-s.org/sites/v-c-s.org/files/Program%20Definitions%20v3.5.pdf>.

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23 See [www.conservation.org](http://www.conservation.org)

the recent developments in the VM0007 REDD+ methodology outlined in Appendix B. Such a guidebook is not known to exist for IFM methodologies.<sup>24</sup> For afforestation and reforestation, the CDM has consolidated a large variety of procedures into four methodologies for wetlands and non-wetlands, large-scale and small-scale. These methodologies are eligible under the VCS standard, and no additional methodologies have since been proposed.

As noted in Chapter 2, the value of conserving and restoring wetlands lies particularly in the storage of soil organic carbon. Methodologies taking account of this are listed in Appendix B. Methodologies present a list of applicability conditions, allowing for a relatively quick assessment of the suitability of the methodology for the particular circumstances.

It is furthermore recommended to check other carbon standards, including standards with a more regional focus such as the American Carbon Registry, the UK Peatland Carbon Code or the German MoorFutures,<sup>25</sup> for eligibility and guidance regarding methodological approaches and project-based blue carbon finance opportunities.

### 4.3.3 Carbon pools

As with other AFOLU projects, coastal wetlands projects should consider five carbon pools: aboveground biomass, belowground biomass, deadwood, litter and soil carbon. Pools can be omitted if their exclusion leads to conservative estimates of the number of carbon credits generated. While changes to the soil organic carbon pool between the baseline and the project is often seen as insignificant in dryland settings, this is generally not the case for wetlands and should be accounted for.

Recognizing that wetlands are generally part of a landscape continuum, it is conservative to

differentiate between CO<sub>2</sub> that is sequestered directly from the atmosphere or water column (known as autochthonous carbon) and CO<sub>2</sub> that has been fixed elsewhere in the landscape, transported and deposited on site (allochthonous carbon). Procedures for distinguishing and accounting for autochthonous and allochthonous carbon are provided within the *VCS Methodology for Tidal Wetland and Seagrass Restoration*.

### 4.3.4 Eligible gasses

Projects must account for any significant sources and sinks of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O that are reasonably attributed to project activities. GHG accounting methodologies provide varying procedures for these gasses. In the context of wetlands, specific attention is needed to quantify emissions of CH<sub>4</sub> and N<sub>2</sub>O. However, certain principles, as described in Chapter 2, may simplify the accounting and are captured in new blue carbon methodologies. These will help to assess if the prospected GHG emission reductions are significant and sufficient.

Not all projects will require detailed monitoring of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. This will depend upon the nature of the project activity and the comparison between the baseline and the project activity. Drained wetlands under agricultural use will likely be a source of N<sub>2</sub>O within the baseline but many restored wetlands will not. Under such conditions, the project proponent may account for the reduction in N<sub>2</sub>O emissions or reduce the level of monitoring effort and not recognize these benefits. Similarly, removing barriers that reconnect tidal saline waters may reduce CH<sub>4</sub> emissions as well as reestablishing carbon sequestration. The project proponent may elect to account for one or both of these, depending upon the cost-benefit of monitoring.

### 4.3.5 Project boundary

Under AFOLU carbon project guidelines, such as those provided by the VCS Standard and VCS AFOLU Requirements<sup>26</sup>, project

24 Refer to [www.v-c-s.org](http://www.v-c-s.org) for approved methodologies.

25 The standard is not available in English. For a German copy see <http://www.bfn.de/fileadmin/MDB/documents/service/skript350.pdf>.

26 See [www.v-c-s.org/program-documents](http://www.v-c-s.org/program-documents)

proponents must clearly define the boundaries of a project to facilitate measurement, monitoring, accounting and verification of the projects emission reductions or GHG removals. The project boundary not only involves the geographic boundary, but also the temporal boundary (often referred to as the crediting period; see the note on permanence below), the carbon pools involved (e.g. biomass, soil organic carbon) and the GHGs accounted for ( $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{N}_2\text{O}$ ).

At project verification (i.e. based on the *ex-post* assessment of the project's achievements based on monitoring results), the geographic project boundary must encompass the area to be under control or to become under the control of the project participants. The VCS, for example, is supportive of such projects on wetlands, which may be enacted along a coastline with locally specific baseline or project conditions, or require the aggregate of numerous small activities within a regional project.

A particular challenge for coastal wetlands projects will be to address moving boundaries of wetlands with sea-level rise. In the determination of geographical project boundaries, project proponents must consider expected relative sea-level rise and the potential for expanding the project area landward to account for wetland migration, inundation and erosion. Carbon accounting methodologies compliant with VCS requirements will provide suitable procedures for this assessment.

An additional challenge is to account for the connectivity of wetlands across the landscape. Wetlands are impacted both positively and negatively by upstream activities that should be accounted for in the baseline and project assessment. Large wetlands restoration projects may also impact downstream conditions, the consequences of which should be considered under ecological leakage.

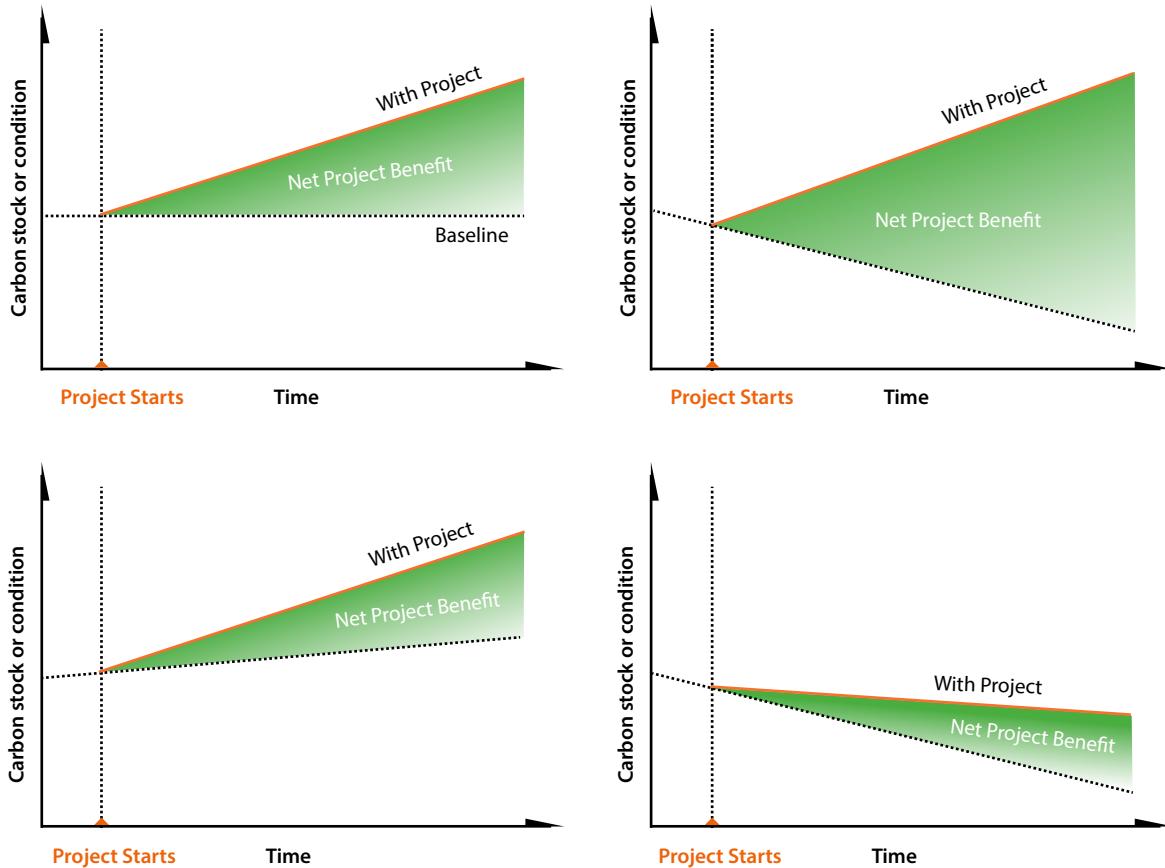
In a managerial sense, setting defined project boundaries also serves as a reality check for developers assessing what area can be reasonably managed and controlled. A common

difficulty for project developers is that area targets (a certain number of hectares, for instance), often in response to donor expectations, are set unrealistically high. A likely consequence is that substantial project resources are invested in 'area searches', that a project includes area pools of first, second and third ranked sites rather than a clearly identified, best suited core site, and that the demarcation of project boundaries is intentionally omitted (or postponed).

#### 4.3.6 Baseline and project scenarios

The emissions benefits of any carbon management project are determined by comparing the outcomes of the project to a baseline, or without a project, scenario. The baseline scenario is the projected outcome in the absence of the project and is sometimes described as the "business-as-usual" scenario. Both the project and baseline scenarios are projected over time and GHG (and other) outcomes quantified. Note that determining net project benefits requires accurately characterizing the initial conditions. From initial conditions, the project and baseline conditions then diverge over time.

While much of the carbon project documentation focuses on the project description, it is also important to describe and document the baseline scenario. A detailed description of current and expected land-use forms and of the drivers of land disturbance and degradation as well as a comprehensive mapping of stakeholders (local communities, governments, economic actors and others) usually is an early and necessary part of identifying a blue carbon project. Fully accounting for activities, drivers of disturbance and stakeholders is needed for an accurate baseline description and in turn allows an informed technical assessment of carbon outcomes. Approaches to baseline assessments abound in current GHG accounting methodologies. For example, the way REDD methodologies structure procedures for the behavior of degradation agents can be applied for blue carbon application.



**Figure 1. Hypothetical illustrations of scenarios demonstrating net benefits of carbon management projects.**

Source: Orlander et al. (2011).

Figure 1 provides a simplified illustration of GHG outcomes for possible scenarios of baseline and project conditions.

The first graph (upper left) illustrates a scenario with a stable baseline over time, with the project projected to improve upon these conditions. Blue carbon examples of this type of project might be mangrove restoration of an abandoned shrimp pond on mineral soils, or removal of a barrier to saline tidal flows thus restoring salinity conditions and reducing  $\text{CH}_4$  emission. The second graph (lower left) illustrates a scenario in which baseline conditions are improving over time and the project would accelerate this improvement. An example

of this would be where coastal carbon is being sequestered through existing coastal ecosystems and additional coastal restoration will generate further increases. The third and fourth graphs (upper and lower right) depict declining baseline conditions where the project would improve on these. Examples of this would be re-wetting drained peatlands or conserving and restoring mangroves. A variant would be that the baseline declines and the project scenario is stable, representing a typical conservation project. Note that carbon storage benefits need not necessarily improve upon initial conditions (lower right graph), as long as there is a net improvement over the baseline.

For coastal blue carbon projects, the likely evolution of the landscape including climate change and human impacts should be taken into account within both the baseline and project scenario. This might for example recognize that coastal wetlands will migrate landwards and may be subject to coastal squeeze or that levees may fail and low-lying, low-value agricultural land convert back to wetlands without human intervention. Because restoring wetlands may begin as bare shallow, open water or tidal flats before vegetation colonizes, trajectories of site evolution through various land cover types must be considered. Coastal systems will continue to evolve over time. Section 4.6 addresses the issues associated with permanence.

#### 4.3.6 Leakage

Leakage refers to a situation where a GHG project activity triggers an emission on areas outside of the project boundary. Two common forms are *activity-shifting leakage* and *market-leakage*. Activity-shifting leakage occurs when activities inside the project boundary (e.g. mangrove deforestation) relocate outside of the boundary. Market leakage occurs when project activities affects an established market for goods (e.g. farmed shrimps) and causes the substitution or replacement of that good elsewhere. The phenomenon of leakage, accounting guidelines and mitigation strategies have been widely researched in the context of REDD, and while blue carbon particularities warrant further assessment, the relevant results are generally adaptable to blue carbon interventions.

An additional form involving open boundary systems has been termed *ecological leakage*. In the case of blue carbon ecosystems, project activities that lead to disruption of sediment supply or modified hydrology resulting in downstream or neighboring GHG impacts need to be accounted for. Monitoring and quantifying ecological leakage may be an onerous burden on WRC projects. If simplifications in the assessment cannot be found, the accounting protocol

may include applicability criteria that render ecological leakage nonexistent or not significant. This can be achieved by ensuring that hydrological connectivity with adjacent areas is insignificant or cause no significant negative wider impact to water levels, flooding frequency or duration and sediment delivery. As conservation projects have the intention to keep the natural hydrology of the project area intact, they are unlikely to cause the abovementioned changes. In such case there will be no ecological leakage.

### 4.4 Community engagement

Approaches to assessing the feasibility of a forest carbon project from a community engagement perspective are described in Blomley and Richards (2011) and of mangrove projects in Lewis III and Brown (2014). Reasons for project proponents to invest time and money in the good practice of engaging with communities include: (1) reducing risk; (2) saving time and money; (3) managing reputational risk in a sensitive marketplace; (4) assessing the market; (5) positioning for adaptation opportunities (in terms of planning and financing) and (6) adhering to international law and conventions (Blomley and Richards 2011).

As described in Section 3.4, project planning should follow community driven (bottom-up) and agency (top-down) capacity building so that there is a clear plan and agreement between community, government and scientists and project proponents on how the activity will be achieved and sustained.

### 4.5 Design the project

A successful blue carbon conservation or restoration project that meets the needs of climate change mitigation and adaptation will be founded on maintaining or reestablishing an ecosystem with a high degree of health or integrity. Indicators for monitoring the integrity of wetland systems are provided by Brouwer et al. 2003.

The likelihood of delivering a successful blue carbon project is greatly improved by having a rigorous process for translating project goals and objectives into project elements or activities. Projects that involve the conservation or restoration of wetlands projects should follow good practice of that industry (Orth and Yoe 1997; Pastorok et al. 1997; Interagency Workgroup on Wetland Restoration 2003; PWA and Faber 2004; Society for Ecological Restoration 2004; Lewis III and Brown 2014).

The steps in defining project activities for wetland conservation and restoration are to:

- define the system of concern and the existing problem(s);
- develop goals and objectives for the conservation or restoration activity, including the time period over which these should be met;
- describe opportunities (benefits) that the project may deliver and constraints challenging the project;
- articulate a conceptual model of the ecosystem functioning to be conserved or restored, articulating the historic condition and existing condition;
- develop project alternatives. (It may be that a single project alternative is clear though often in multi-use landscapes more than one alternative may exist.);
- evaluate project alternative conceptual/ preliminary designs against environmental, economic social and other considerations by comparing future conditions for with-project and baseline scenarios (as described for GHG assessment in Section 4.3.6);
- select the preferred alternative;
- develop the final restoration design and implementation plan for the preferred alternative.

## 4.6 Assess non-permanence risk and uncertainty

### 4.6.1 Permanence

In this context, permanence generally refers to the longevity of a carbon pool. Under most

carbon standards, an increased carbon stock or avoided loss of carbon stock as a result of a project activity must be maintained for a long period and its reversal must be avoided. Permanence is important when emission reductions or removals are used as offsets – if the underlying carbon stock disappears, the offset will also be affected.

Blue carbon ecosystems store carbon within soils, as well as aboveground biomass. These stocks are held in place as long as the ecosystem remains undisturbed. High rates of sea-level rise may drown intertidal wetlands leading to a loss of ongoing sequestration and aboveground stocks, but carbon buried in soils and maintained in position will largely remain sequestered. Restoration of blue carbon ecosystem reinitiates the carbon sequestration process.

Some activities will have a potentially low risk to non-permanence (such as conserved wetlands at the inner reaches of deltas with high sediment delivery) or have no risk at all (such as activities that reduce  $\text{CH}_4$  or  $\text{N}_2\text{O}$  emissions from baseline conditions). In other cases, risk to non-permanence will raise questions over project selection when carbon stock may be lost in the long-term (e.g. with eroding coastlines in project scenarios).

Human activities are the largest threat to permanence of accumulated carbon stocks. Wetland clearance, excavation with landside disposal of material, and wetland drainage are major threats to the permanence of carbon storage. Sea-level rise is a threat to carbon projects in that carbon stocks in accumulated biomass will be lost along with ongoing sequestration potential if the intertidal wetland drowns. Drowning of projects in intertidal areas can be avoided by selecting sites that are resilient to sea-level rise (high sediment availability, robust vegetation growth and/or gradual slope for wetland migration).

Current carbon standards offset the risk of non-permanence by issuing only temporary credits (CDM, see above), or by installing a

fixed (e.g. Gold Standard) or variable buffer withholding, for which the VCS is a good example. In the standard's language, the "non-permanence risk analysis only needs to be applied to GHG removals or avoided emissions through carbon sinks. Project activities generating emissions reductions of  $N_2O$ ,  $CH_4$  or fossil-derived  $CO_2$  are not subject to buffer withholding, since these GHG benefits cannot be reversed".<sup>27</sup> For our opinion on this rather wide scope, see Appendix C. Non-permanence risk is seen to consist of three risk factors, internal, external, and natural risks, for which rating can be obtained. The total risk rating shall not exceed a value of 60% or the project risk is deemed unacceptably high and thus the project not eligible. Note that each percentage withholding means a deduction on the return on investment, although the standard has created opportunities to reduce the withholding over time. The potential transient and permanent losses in carbon stocks shall be assessed over a period of 100 years. This represents a challenge to blue carbon interventions (and any other AFOLU activity); therefore, it is recommended that the risk assessment is performed, with any data available supplemented with educated assumptions, at the very early stages of project development.

#### 4.6.2 Scientific uncertainty

For some coastal settings it is broadly possible to forecast coastal response to climate change. Conservation and restoration of tidal wetlands in sheltered locations with high sediment availability will maintain wetlands with sea-level rise or will rapidly rebuild new wetland. Coastal systems unimpaired by human infrastructure, irrespective of sediment supply, but upon suitable topography, will see a landward migration with sea-level rise, perhaps with intertidal wetlands displacing terrestrial lands, and sea grasses displacing intertidal wetlands. Tidal wetlands supporting reeds (found in freshwater and brackish water conditions) appear to offer high carbon

sequestration benefits both in managed and dike breach conditions (Miller et al. 2008; Crooks et al. 2014). Coastal wetlands with a low mineral sediment supply and vegetation with low productivity will respond poorly to sea-level rise. For many other coastal wetland systems, there will be considerable uncertainty in the projections of future landscape change.

An additional uncertainty is the fate of carbon eroded from wetland margins and redistributed across the estuary. To some degree, buried carbon will have already undergone a certain level of decomposition with release of the most readily consumed carbon fraction. As such, the mobilized carbon reflects the less consumable carbon fraction. Nevertheless, some of this carbon is likely to be returned to the atmosphere unless it is buried in a rapidly accumulating sediment sink, such as the margins of a large delta. In the *VCS Methodology for Tidal Wetland and Seagrass Restoration* the proponent must take conservative assumptions in project accounting for these potential emissions within the baseline and project scenarios.

### 4.7 Secure project development finance and structure agreements

#### 4.7.1 Financial feasibility

The financial feasibility assessment examines the project business plan and cost inventory and structures the carbon finance contributions. Where a project aims at carbon revenues, the credit and cash flows need to be fine-tuned, in particular when a project depends, as many blue carbon projects do, on multiannual advance (or seed) funding.

The financial analysis will often be central to the carbon pricing approach. In the absence of internationally fixed carbon prices, the project costs (for building infrastructure, managing the projects, paying staff, etc.) will translate into the price per carbon credit (calculated for a project amortization period of between 10

<sup>27</sup> See the VCS AFOLU Non-Permanence Risk Tool at [www.vcs.org/program-documents](http://www.vcs.org/program-documents)

and 30 years). If some of the costs are carried by a public source, we need to assess whether or not such subsidies are to be deducted from project costs (resulting in a lower final carbon price) or not. Some corporate and social responsibility (CSR) buyers have shown resistance in the past to indirectly benefit from public funding. In many cases, a mixed approach, in which some costs are (e.g. concerning the development of a methodology) but others are not treated as deductible (e.g. concerning the development of project documentation) seems a reasonable way forward, if it is understood that any surplus revenues may go fully into project growth or other nature conservation investment.

For available international climate finance sources see the examples listed in Box 6.

## 4.7.2 Legal and institutional feasibility

The legal and institutional feasibility assessment is largely done outside the carbon standard assessment, even though various standards – notably the VCS – make frequent reference to legal concepts (such as ‘proof of title’, ‘evidence of right of use’, ‘illegal logging’, ‘sanctioned degradation’, etc.) and even though validators will check these concepts against the project particularities in question. However, while legal and institutional factors provide the environment for a project and/or a precondition, they do not define a project as such, and carbon standards give few instructions, if any, for the legal and institutional set-up of a project and, importantly, for the claim to,

## Box 6. International climate finance

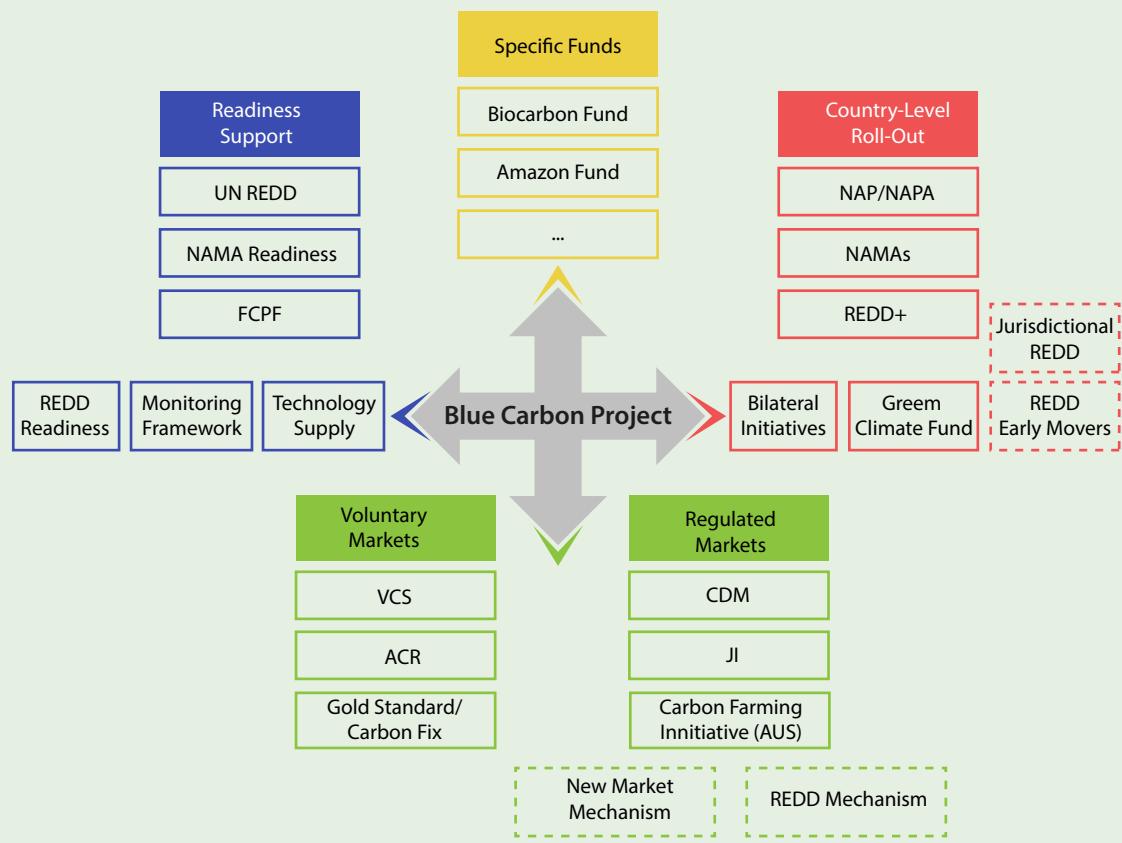
A blue carbon project developer will need to examine carefully whether there are international climate finance formats that have a bearing – positive or negative – on its activities and results (see figure below in this box). She may be able to rely on direct support under a countrywide or jurisdictional Nationally Appropriate Mitigation Action (NAMA) or Reducing Emissions from Deforestation and forest Degradation (REDD) program or an adaptation measure (e.g. a National Adaptation Plan (NAP)) or funding through institutions such as the Green Climate Fund (soon to be operational), the Kyoto Protocol based Adaptation Fund, the World Bank BioCarbon Fund or the Amazon Fund. In any case, existing (or absent) climate finance schemes and interventions will guide her in the overall feasibility assessment. In particular, a country that engages in REDD readiness activities – under UN REDD and/or the Forest Carbon Partnership Facility (FCPF), a UN-led program the former, and public-private partnership administered by the World Bank, the latter – is *a priori* a favorable environment for a blue carbon project.

Blue carbon interventions at all levels – State, jurisdictional or project – can benefit from these facilities on a number of diverse issues ranging from clarification of tenure rights to the improvement of institutional capacities and better monitoring capacity. Jurisdictional (REDD) programs may apply, which may offer project development windows within its scope (“nesting”). Project developers, in particular, are advised to seek guidance from the facilities in question and, in any case, take note of their (usually widely publicized) intervention reports for due diligence purposes. Project developers who wish to generate carbon credits – under regulated markets (such as Joint Implementation (JI) or the Clean Development Mechanism (CDM) and potentially, in the future, a New Market Mechanism or a REDD Mechanism) or voluntary markets (such as the Verified Carbon Standard (VCS) or the American Carbon Registry (ACR) or the Gold Standard) – will also need to assess whether there are competing accounting or crediting instruments at the country or at the jurisdictional level. For instance, APB Birdlife, a

**Box 6.** Continued

Belarus-based NGO, is currently developing a peatland re-wetting carbon project in Belarus. So far, Belarus does not account for its peatland related emissions; thus, a competing claim between the VCS and a national accounting scheme does not exist. However, should Belarus adopt an accounting approach in the future, a conflict between VCS project-level crediting and country-level crediting may arise. Similarly, the Brazilian region of Acre is currently developing a jurisdictional REDD approach and is participating

in the German-funded REDD Early Movers program, which targets so-called 'results-based' REDD action. Should a project developer in Acre wish to develop a peatland project or should any coastal State developing jurisdictional REDD engage in a blue carbon project, which overlaps with REDD activities, the issue of double-accounting needs to be addressed. Blue carbon project developers should plan for this well in advance of implementation.



**Figure 2. Blue carbon projects in an international climate perspective**

and trade of, carbon credits generated. The emergence (and wide recognition) of the policy principle of 'free prior and informed consent' (FPIC), applicable to local landholders and communities, when engaging in land-based projects and, consequently, carbon standards, nonetheless helps fill some of the 'legal gaps'.

Generally, for a project developer and a carbon developer alike, the legal and institutional structure of the project and the legally sanctioned control over the project area – in a public law sense (land categorization, land planning, environmental regime, etc.) and in a private law sense (land tenure) – is of great importance, and its examination and identification process (including FPIC) is a necessary part of any feasibility assessment. Where a blue carbon project aims to generate carbon credits, then the specific legal transaction features, for their part, influence project implementation on a variety of levels. Understanding and managing the relevant features – concerning the transaction object, pricing, funding flows, revenue distribution, transaction liabilities, and others – is equally important.

#### 4.7.3 Public law and the land

Blue carbon project activities are particularly exposed to public law regimes. The area in question may be subject to a particular land-use regime (e.g. production forest land, fishery zone, shipping transit zone) or conservation regime (e.g. national parks, national REDD regimes, other). Consequently, at the feasibility stage, a number of tests need to be performed and different legal layers need to be distinguished. First, with regard to current land-use activities, the project developer needs to establish whether they occur in compliance with the relevant legal regime (e.g. a planned settlement or farming program; an infrastructure campaign including river regulation and stream straightening, shipping rights, etc.) or not. If certain activities do, then implementing the project activity and changing the ongoing land use may require dedicated legal action (e.g. purchase of land, request to the government to change land use or shipping

regime or other) or prove nonviable. If the relevant legal regime is currently not complied with or if the legality of land use is not clear, then a particular focus needs to be given to governance, the participatory capacity of local communities to engage and the institutional capacity of the government to clarify and enforce its laws. A failure to effectively enforce existing laws often facilitates land degradation, and the preeminent challenge for a project developer will be to improve governance and law enforcement. A separate public law issue may arise in the context of complementary and sometimes competing climate (finance) regimes that govern the project or the project area. For the implications see the box on this page.

Second, the project proponent needs to have established whether the envisaged land uses (project activities) are legal and whether they require a particular license. It may appear that whether or not a formal blue carbon license is obligatory cannot be finally settled. In the context of REDD, many countries have chosen to regulate relevant activities in their forestry code, but the exact implications for project developers (in particular the carbon finance components) are not always clear. The voluntary nature of many carbon regimes – notably the VCS – is not always an indication that a license would not be required. In any case, project developers should engage with the relevant authorities proactively and seek (written) appraisal of some form (e.g. through a memorandum of understanding), while particular attention should be given to explaining the details of the project activities (actions, boundaries, proponents, etc.) and to clearly setting out the revenue distribution scheme, in case the project aims to generate carbon credits.

#### 4.7.4 Land tenure

The envisaged project activities must respect private title and private claims to land – whether based on contract (e.g. property, lease), statute (e.g. recognized community claims) or custom (e.g. traditional fishing rights of indigenous populations) – and rightful

landholders must have given their approval within the FPIC process, in particular in the context of customary usage)<sup>28</sup> to the project prior to implementation. Particular challenges are to be expected in cases where land tenure is difficult to establish, where the identity of legitimate landholders is not clear and where conflicting legal regimes apply.

#### 4.7.5 Carbon rights

A major stumbling block for carbon projects (land-use related carbon projects in particular) has become the issue of defining and allocating 'carbon rights'. There is only fairly recent precedent for carbon rights classification, and for traditional legal systems the conceptualization is not easy. A variety of factors contribute to the complexity: 'Carbon rights' refer to positive or negative greenhouse gas emissions resembling an intangible, abstract concept (not a standardized natural commodity), yet different from an individualized creation of mind (intellectual property). For land-based carbon rights, the elusive nature is all the more apparent (and complicated), as the land both stores and emits the carbon accounted for and isolated as a right. The situation is not helped by the fact that the allocation of land and land rights is closely associated with a country's sovereignty; claiming (and selling) carbon rights is therefore often understood as a highly sensitive political matter.

From a point of view of legal theory – and positive law – the issue of carbon rights is less problematic than it seems. As there is no tangible or intangible benefit inherent in a carbon right, its existence is solely one of regulation (e.g. under an emissions trading scheme) or of mutual (contractual) agreement (e.g. a transaction on the basis of the VCS). As long as a legal system (domestic or supranational) does not regulate carbon rights, they exist on a contractual (voluntary) basis only, and abstract property discussions

(concerning the *erga omnes* effect of carbon rights), let alone sovereignty discussions, are then beside the point. Note, however, that this detail is often little understood (not least by governments), and that projects and carbon transactions can be blocked by lengthy, if redundant, carbon right property discussions. It is important, therefore, that a project proponent in a voluntary project procures clarification of the matter early in the process through (i) identifying whether carbon credit regulation exists, whether (ii) there is crediting precedents from other projects, and (iii) where needed, engaging with relevant government departments to determine the credit status of the project, it being understood that *voluntary* carbon market transactions are essentially project grants paid in accordance with milestone achievements (emission reduction thresholds); and that carbon registries in this constellation trace achievements, little else.

#### 4.7.6 Carbon transaction

If the intervention engages in the sale of carbon credits, then the structure of the transaction must be agreed. A carbon transaction is a contract that defines the objective (the sale and transfer of a certain amount of carbon credits), identifies the seller and the buyer, the carbon price and the details of delivery and payment, and this includes any specific provisions the contractual parties deem fit to agree on. A voluntary market blue carbon transaction is likely to include provisions on benefit-sharing (among project proponents, local communities, perhaps the government, and others) and may incorporate a specific financial mechanism, or the creation of a special financial purpose vehicle, to govern finance flows. As part of the feasibility assessment, various options for the transaction structure and the benefit-sharing and financial design may be assessed.

### 4.8 Assess social and environmental changes

A question must always be asked: "will this land-based project be good for people,

28 C.f. Anderson, P, Free, Prior, and Informed Consent in REDD+. Principles and Approaches for Policy and Project Development (2011), accessible at [http://www.forclime.org/images/stories/RECOFTC-GIZ\\_FPIC\\_in\\_REDDE\\_2011.pdf](http://www.forclime.org/images/stories/RECOFTC-GIZ_FPIC_in_REDDE_2011.pdf).

biodiversity and ecosystem services?” (Durbin and Jenkins 2011). On the human side, many in rural communities are keen to embark on carbon projects because of the promise of income generation as well as conserving or restoring an environment of economic, spiritual or intrinsic value to them. Similarly, conservationists are motivated to attract long-term funding streams to maintain habitat and ecosystem services. The carbon offset buyer and investor is motivated by the attraction of supporting projects that bring social and environmental benefits while at the same time offsetting emissions. Regulators often require an assessment of environmental impacts, particularly disclosure of any negative impacts, as a condition of project permits. With many interests, it is important that adequate attention is paid to ensuring that the interests of all parties is balanced and protected as part of the project planning and implementation.

Best practices for assessment of project impacts – positive and negative – consider

short- and long-term changes over time, and compare with-project to baseline scenario outcomes (similar to the scenario analysis described for GHG removal in Section 4.3.6). For more on social and biodiversity impacts assessments the reader is recommended to read Richards and Panfill (2011).

## 4.9 Regulatory compliance

A number of countries have enacted State or federal regulations to protect and conserve wetlands and coastal systems. The requirements of such regulations must be adhered to within project planning and implementation. Blue carbon interventions will most likely fall in line with the goals of policies and the requirements of regulations. Wetlands conservation activities act to protect existing wetlands. Restoration activities bring back wetland systems. Good project design should avoid conflicts with regulations to protect environmental quality during construction and implementation.





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## Appendices

## Appendix A. Additional resources

CIFOR Sustainable Wetlands Adaptation and Mitigation Project  
<http://www.cifor.org/swamp/home.html>

International Blue Carbon Initiative  
[www.thebluecarboninitiative.org](http://www.thebluecarboninitiative.org)

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

Verified Carbon Standards  
<http://www.v-c-s.org/>

NOAA Habitat Conservation - Coastal Blue Carbon  
[www.habitat.noaa.gov/coastalbluecarbon.html](http://www.habitat.noaa.gov/coastalbluecarbon.html)

Abu Dhabi Blue Carbon Demonstration Project  
<http://abudhabi.bluecarbonportal.org/>

Blue Carbon Indonesia  
[www.facebook.com/pages/Blue-Carbon-Indonesia/311239892223268](http://www.facebook.com/pages/Blue-Carbon-Indonesia/311239892223268)

Blue Ventures - Blue Forests Programme  
[www.blueventures.org/conservation/blue-forests](http://www.blueventures.org/conservation/blue-forests)

Mikoko Pamoja Kenya Mangrove Carbon Project  
<http://www.planvivo.org/projects/registeredprojects/mikoko-pamoja-kenya/>

Restore America's Estuaries Blue Carbon Page  
<http://www.estuaries.org/climate-change.html>

Forest Trends Library on Carbon Project Activities  
<http://www.forest-trends.org/publications.php>

Duke University - Coastal Blue Carbon Initiative  
<http://nicholasinstitute.duke.edu/initiatives/coastal-blue-carbon>

Mangrove Forest Rehabilitation Report (2014)  
<http://www.mangroverestoration.com/pdfs/Final%20PDF%20-%20Whole%20EMR%20Manual.pdf>

The Blue Carbon Portal  
[www.bluecarbonportal.org](http://www.bluecarbonportal.org)

The Importance of Mangroves to People: A Call to Action" UNEP report 2014  
<http://goo.gl/C5b1Es>

## Appendix B. Carbon project categories and methodologies

**Table B1. Blue carbon interventions and project categories recognized in the VCS AFOLU requirements.<sup>29</sup>**

Baseline scenario		Project activity	VCS AFOLU category
Pre-project condition	Land use		
Degraded wetland (including, drained, impounded, and with interrupted sediment supply)	Non-forest (including aquacultures, shrublands and grasslands)	Restoring wetlands <sup>#</sup>	RWE
		Restoring wetlands <sup>#</sup> and revegetation or conversion to forest	RWE+ARR
		Restoring wetlands <sup>#</sup> and conversion to wetland agriculture (including paludiculture)	RWE+ALM
		Restoring wetlands <sup>#</sup> and avoided conversion of grassland or shrubland	RWE+ACoGS
	Forest	Restoring wetlands <sup>#</sup>	RWE
	Forest with deforestation/ degradation	Restoring wetlands <sup>#</sup> and avoided deforestation	RWE+REDD
	Forest managed for wood products	Restoring wetlands <sup>#</sup> and improved forest management	RWE+IFM
Non-wetland or open water	Non-forest	Creation of wetland conditions and afforestation, reforestation or revegetation	RWE+ARR
	Open water or impounded wetland	Creation or restoration of conditions for afforestation, reforestation or revegetation	RWE+ARR
Intact wetland	Non-forest (including shrubland and grassland)	Avoided drainage and/or interrupted sediment supply	CIW
		Avoided conversion to open/ impounded water (including excavation to create fish ponds)	CIW
		Avoided drainage and/or interrupted sediment supply and avoided conversion of grasslands and shrublands	CIW+ACoGS
	Forest	Avoided drainage and/or interrupted sediment supply	CIW
		Avoided conversion to open/ impounded water	CIW
	Forest with deforestation/ degradation	Avoided drainage and/or interrupted sediment supply and avoided deforestation/degradation	CIW+REDD
		Avoided conversion to open/ impounded water and avoided deforestation/degradation	CIW+REDD
	Forest managed for wood products	Avoided drainage and/or interrupted sediment supply and improved forest management	CIW+IFM

<sup>#</sup>) This involves:

Restoring Wetland Ecosystems (RWE): Activities that reduce GHG emissions or increase carbon sequestration in a degraded wetland through restoration activities. Such activities include enhancing, creating and/or managing hydrological conditions, sediment supply, salinity characteristics, water quality and/or native plant communities.

Conservation of Intact Wetlands (CIW): Activities that reduce GHG emissions by avoiding degradation and/or the conversion of wetlands that are intact or partially altered while still maintaining their natural functions, including hydrological conditions, sediment supply, salinity characteristics, water quality and/or native plant communities.

The VCS AFOLU requirements specify various project activities together with specific conditions that need to be met for eligibility under the program.

ARR: Afforestation, Reforestation, Revegetation

ALM: Agricultural Land Management

ACoGS: Avoided Conversion of Grassland and Shrubland

REDD: Reducing Emissions from Deforestation and forest Degradation

IFM: Improve Forest Management

29 See [www.v-c-s.org/program-documents](http://www.v-c-s.org/program-documents)

### VM0007 REDD+ methodology (VCS - Avoided Deforestation Partners, Permian Global, Restore America's Estuaries)

The comprehensive procedures in this modular methodology are applicable to project activities that reduce emissions from deforestation and forest degradation, for afforestation (REDD), reforestation and revegetation activities (ARR), wetlands restoration or conservation (WRC), or combinations of these. Under the WRC banner, peatland conservation and rewetting procedures are included in 2014, while coastal wetlands will be added in 2015. The methodology intends to cover the entire range of project activities eligible under these three VCS project categories, providing maximum flexibility in the use of accounting procedures in complex settings where conservation and rehabilitation are combined, as well as in single category interventions.

### Methodology for tidal wetlands and seagrass restoration (VCS - Restore America's Estuaries)

The methodology outlines VCS-approved procedures to estimate net GHG emission reductions and removals resulting from restoration of tidal wetlands and seagrass beds along the entire salinity range, via enhancing, creating and/or managing hydrological conditions, sediment supply, salinity characteristics, water quality and/or native plant communities. The restoration activities intend to protect and re-establish environmental benefits, including emission reductions and carbon sequestration.

### Restoration of Degraded Deltaic Wetlands of the Mississippi Delta (ACR-Tierra Resources LLC)

This methodology, approved by the American Carbon Registry<sup>30</sup>, details procedures

for greenhouse gas emission reduction accounting from wetland restoration activities implemented on degraded wetlands of the Mississippi Delta (hence with a limited geographic scope). The modular format provides flexibility for numerous types of wetland restoration projects including those that require hydrologic management, and whether wetland loss will be included in the baseline.

### AR-AM0014 - Afforestation and reforestation of degraded mangrove habitats (CDM)

The methodology outlines CDM-approved procedures to estimate net GHG emission reductions and removals resulting from afforestation or reforestation of mangroves. The methodology allows use of mangrove species and non-mangrove species but in case of more than 10 per cent area being covered by planting of non-mangrove species it prohibits changes in the hydrology of the project area. The methodology restricts the extent of soil disturbance in the project to be no more than 10 per cent. Project activities applying this methodology may choose to exclude or include accounting of any of the carbon pools of dead wood and soil organic carbon, but cannot include the litter carbon pool.

### AR-AMSO003 - Simplified baseline and monitoring methodology for small scale CDM afforestation and reforestation project activities implemented on wetlands (CDM)

The methodology outlines CDM-approved procedures to estimate net GHG emission reductions and removals resulting from afforestation or reforestation of wetlands following the simplified modalities for small-scale projects under the CDM.

30 See [americancarbonregistry.org](http://americancarbonregistry.org)

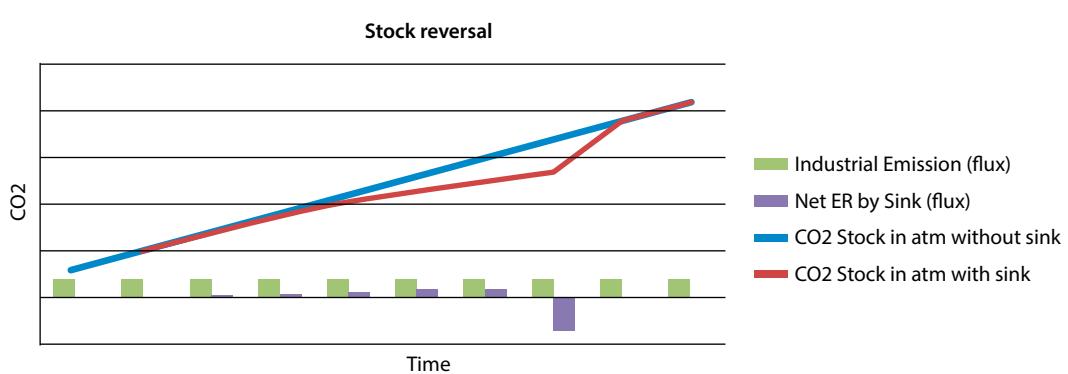
## Appendix C. Permanence in AFOLU interventions<sup>31</sup>

In various projects it is clear that an emission reduction cannot be reversed. Methane from a waste dump, that is captured and burned, cannot be turned back into methane and consequently the realized emission reductions are permanent. In contrast, the sequestration of CO<sub>2</sub> in ecosystems can be reversed.

Carbon sequestration by afforestation or reforestation (A/R) can be undone deliberately (through land-use change or wood harvest) or unintentionally (by wildfires or other calamities), so that the carbon stored in the forest is emitted again into the atmosphere and the carbon credits issued are annihilated.

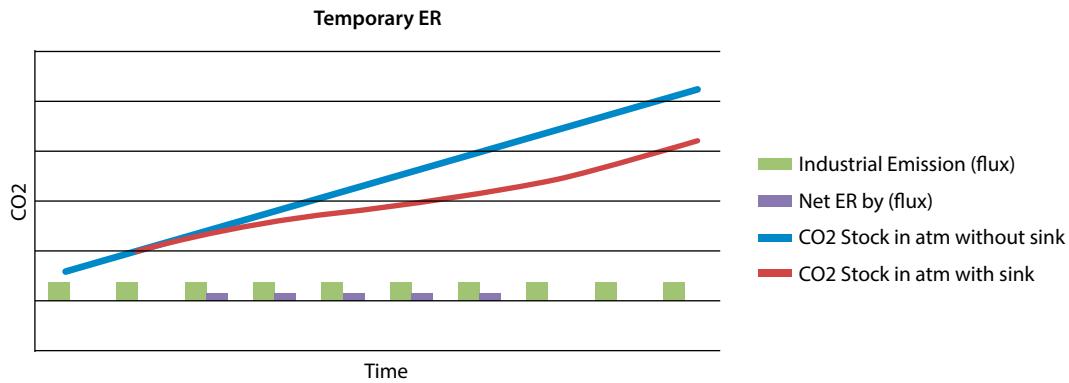
The fear of non-permanence is pervasive, both in the voluntary (e.g. VCS) and in the compliance markets (e.g. CDM). To avoid or mitigate the risk of reversals, long-term contracts have to be constructed or legal measures taken (e.g. designation to protected area) and non-permanence risk buffers or insurances have to be installed.

The fear of non-permanence is instigated because climate projects within the land sector were hitherto dominated by A/R projects, where reversal is indeed a major issue of consideration. This focus has prevented the recognition of important types of land-use projects that are not subject to non-permanence, i.e. emission reduction/avoidance projects. With the demand for permanence AFOLU-emission-avoidance projects are unjustifiably treated different from energy projects where temporary reductions of emissions from fossil fuels do not raise any concerns. The latter is motivated by the argument that not burning fossil energy carriers (oil, gas, coal) leads to a permanent reduction of CO<sub>2</sub> concentration in the atmosphere compared to the case if these fuels were burned. This reduction persists, also when the project after a while fails and the emissions rise again to former levels.



**Figure C1.** In a sink project (e.g. afforestation), CO<sub>2</sub> is sequestered from the atmosphere and stored as carbon in the upgrowing wood biomass. Consequently the CO<sub>2</sub> concentration in the atmosphere is reduced. If after or during the project the wood is felled (and the wood is not used in durable products), the stored carbon is again released as CO<sub>2</sub> and the atmospheric CO<sub>2</sub> concentration is no longer reduced in comparison to the reference. In a sink project, reversal thus leads to a return to the original (projected) atmospheric CO<sub>2</sub> concentrations.

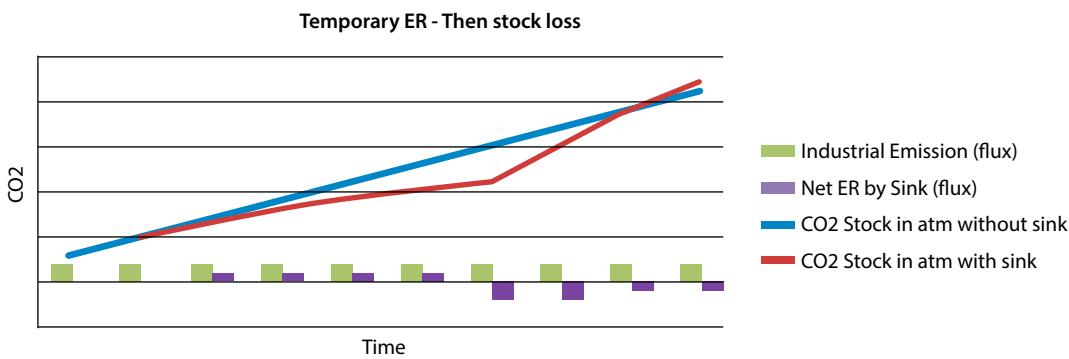
<sup>31</sup> Modified excerpt from Von Unger, M./Emmer, I. / Couwenberg, J./Joosten, H., Carbon Market Approaches for Peatlands and Forests. UBA (2014).



**Figure C2.** In an avoidance project (e.g. peatland re-wetting, REDD+) less CO<sub>2</sub> is emitted into the atmosphere. When after the project intervention the peatland is drained again or the forest anyhow cut, the annual emissions return to the old (reference) level, but in comparison to the reference scenario the CO<sub>2</sub> concentration remains permanently lower. In an avoidance project, a reversal thus does not lead to a loss of the achieved reduction.

The decisive question with respect to the land sector is whether a carbon sink is created or a source avoided or reduced. In the case of a sink project (Figure C1), e.g. afforestation, a latter release of the sequestered carbon leads to an annihilation of the effect of the former sink. Consequently, no substantial long-term mitigation takes place, as the

CO<sub>2</sub> concentration in the atmosphere is not lowered. If the carbon re-release happens only after a longer time (e.g. 50 years), at least until that moment a positive effect on the climate has been achieved. It becomes a policy decision whether this temporary effect is (still) certified and can be awarded financially.



**Figure C3.** Emission reduction and then complete stock loss or emissions beyond the baseline rate (e.g. when a drained peatland is re-wetted and then re-drained at a higher level than ever before).

In case of emission reductions in a peatland re-wetting of a REDD+ project, a stop of that emission reduction does not lead to an annihilation of the positive climate effect (Figure C2). Also, when after a number of years with reduced deforestation, deforestation proceeds at the former rate, or when peat oxidation restarts again when after the project finishes, the constructed dams collapse, the CO<sub>2</sub> concentration in the atmosphere remains permanently reduced compared to the situation without the project. In contrast to sink projects, emission reductions in AFOLU projects do not have – similar to energy projects – non-permanence problems.

Discussions with the VCS are ongoing, and the standard may accept this position at some point in the future.

The only non-permanence scenario for emission reduction projects is a complete stock loss or emission beyond the baseline rate (Figure C3) – yet this scenario had best be aligned to energy-based beyond-baseline scenarios: Either it should equally be ignored (i.e. it would have no impact on the permanence of previously achieved emission reductions) or, in both cases a risk buffer or insurance mechanism should apply.

