Coastal Blue Carbon in Practice

A Manual for Using the VCS Methodology for Tidal Wetland and Seagrass Restoration VM0033

2015 | V 1.0

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Acknowledgments

This manual was made possible through lead financial support from the National Estuarine Research Reserve System Science Collaborative (under the Waquoit Bay NERR Bringing Wetlands to Market: Nitrogen and Coastal Blue Carbon Project). Additional financial support was provided by The National Oceanic and Atmospheric Administration's Office of Habitat Conservation, The Ocean Foundation, The Curtis and Edith Munson Foundation, and KBR.

We would also like thank reviewers of this manual: Steve Crooks, James Eaton, Holly Greening, Jennifer Howard, Amber Moore, Daniel Murdiyarso, Doug Myers, Brian Needelman, Keeley O'Connell, and Scott Settelmyer. Early contributions to the additionality analysis were made by graduate students Natalie Kraft and Leland Moss.

Cover photo credited to the Coalition to Restore Coastal Louisiana restoration project at Fifi Island, LA. 2010.

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Preamble

Coastal blue carbon – the capacity of seagrasses, mangroves, marshes, and other tidal wetlands to sequester and store significant amounts of carbon – is a newly recognized ecosystem service that has great potential to impact coastal conservation and restoration efforts. Globally these ecosystems are being lost at rates of 0.7 to 7% a year (Mcleod et al. 2011), despite the well-known benefits these habitats provide, including shoreline stabilization, improved water quality, and key habitat for many marine species. As the recognition of the carbon value of coastal ecosystems escalates, the increased valuation of these natural resources has the potential to impact policy and market initiatives for the benefit of coastal habitat restoration.

Policy initiatives around 'coastal blue carbon' have recently started to gain traction and the first pilot activities have been designed and are in the process of implementation. Scientist, policy makers, ecosystem restoration experts, and carbon project developers are increasingly cooperating on developing carbon concepts to benefit coastal ecosystems towards a common approach, aiming to avoid duplication of efforts, to share relevant experiences, and to tap into synergies as well as economies of scale. There is considerable know-how available from carbon projects in the forestry sector and increasingly also in the peatland sector, which can be drawn from to further develop coastal blue carbon projects.

Studies have shown that coastal blue carbon ecosystems are significant carbon sinks, presenting new opportunities for carbon finance to benefit wetland habitat restoration and conservation efforts. Prior to 2012, coastal wetland project activities were not eligible for carbon offset generation. However, the Verified Carbon Standard, a leading global carbon offset mechanism, has since expanded its project activities to include a wetlands category. Now wetland restoration (including creation) and conservation activities are eligible to generate carbon offsets. The development of the Methodology for Tidal Wetland and Seagrass Restoration ('Methodology'), approved by the Verified Carbon Standard for verification(VM0033), is the first globally applicable methodology for coastal wetland restoration activities and provides project developers with the protocol needed to generate wetland carbon credits. The Methodology outlines procedures to estimate net greenhouse gas emission reductions and removals resulting from restoration of coastal wetlands along the entire salinity range. The scope of the Methodology is global and includes all tidal wetland systems, including mangroves, tidal marshes, tidal forested wetlands, and seagrass meadows. It incorporates best practices and principles in restoration and carbon management, while leaving the flexibility necessary to enable projects to emerge in diverse coastal settings.

The dynamic nature of coastal wetlands adds additional factors, which require additional planning steps before embarking on a blue carbon project. This Manual is meant to be used alongside the Methodology to identify the key elements of blue carbon asset generation. This Manual aids project developers as they look at the main phases of carbon project implementation: feasibility and site selection, documentation, registration, implementation, and carbon asset management. It builds on robust experience from peatland and forestry projects worldwide, emerging blue carbon pilot projects, and relevant research.

This Manual aids project developers as they look at the main phases of carbon project implementation: feasibility and site selection, documentation, registration, implementation, and carbon asset management.

While coastal blue carbon projects are still in their infancy, this Manual is a first effort to outline the practical and logistical side of blue carbon project development. The Manual will likely need to be updated once such projects come along at a greater scale, including the integration of conservation projects. The Manual answers questions on how to set-up, implement, and organize a blue carbon project on the ground – rather than on the regulatory framework and the position of blue carbon in the international climate change architecture. It addresses the practical challenge of blue carbon project management and is a guide through the different steps of carbon asset (credit) generation using a single regulatory and voluntary standard as its reference, the Verified Carbon Standard (VCS). As a guiding document, this Manual is aimed at blue carbon development initiatives in both industrialized and developing countries.

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Abbreviations

ACoGS	Avoided Conversion of Grassland or Shrubland
ACR	American Carbon Registry
AFOLU	Agriculture, Forestry, and Other Land Use [VCS project scope]
ALM	Agricultural Land Management
A/R	Afforestation and Reforestation [CDM project category]
AR	Afforestation and Reforestation [standard neutral]
ARR	Afforestation, Reforestation, and Revegetation [VCS project category]
BAU	Business-As-Usual
CAR	Carbon Action Reserve
CCBA	Climate, Community, and Biodiversity Alliance
CDM	Clean Development Mechanism
CER	Certified Emission Reduction [CDM]
CIW	Conservation of Intact Wetlands
CME	Coordinating or Managing Entity
FAO	Food and Agriculture Organization
GHG	Greenhouse Gas
GIS	Geographic Information System
GPS	Global Positioning System
GS	Gold Standard
IFM	Improved Forest Management [VCS project category]
IPCC	Intergovernmental Panel on Climate Change
lCER	Long-term Certified Emission Reduction
JNR	Jurisdictional and Nested REDD+
LoA	Letter of Approval [CDM]
MoU	Memorandum of Understanding
MRV	Measurement, Reporting, and Verification
MtC	Megatonnes of Carbon
NGO	Non-governmental Organization
OTC	Over-the-Counter
PD	Project Description [VCS]
PDD	Project Design Document [CDM]
PDT	Peat Depletion Time
PIN	Project Idea Note
PoA	Programme of Activities [CDM]
PRC	Peatland Rewetting and Conservation
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	REDD, including conservation, sustainable management of forests, and enhancement of forest carbon stocks
RWE	Restoring Wetland Ecosystems
SDT	Soil Depletion Time
SPV	Special Purpose Vehicle
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VCS	Verified Carbon Standard (formerly Voluntary Carbon Standard)
VCU	Verified Carbon Unit [VCS]
WRC	Wetland Restoration and Conservation

Glossary of Terms

Activity-Shifting Leakage– Activities that directly cause carbon-emitting activities to be shifted to another location outside of the project boundaries, cancelling out some or all of the project's carbon benefits. An example would be a wetlands project that displaces farmers and leads them to clear adjacent habitat.

Agriculture, Forestry, and Other Land Use (AFOLU) – The sectoral scope that covers GHG emissions and emission reductions and/or removals from project or program activities in the agriculture, forestry, and other land use/land use change sectors and for which the VCS Program has established rules and requirements with respect to specific project categories (VCS Program Definitions).

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

Autochthonous Carbon – Carbon produced and deposed in the same location. In the context of blue carbon systems, this type of carbon results from vegetation uptake of CO_2 from the ocean and/or the atmosphere that is converted for use by plant tissues and decomposes into soils.

Baseline Scenario– A projection of the status quo or "business as usual" (BAU), i.e., during the crediting period without the project.

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. Also referred to as 'blue carbon.'

Carbon Intervention (or Blue Carbon Intervention) –A policy or management activity that results in improved conditions of carbon stocks or reduced GHG emissions. Carbon finance projects are one but not the only form of blue carbon intervention.

Carbon Inventory – An account of the emissions of CO_2eq (carbon dioxide equivalents) to the atmosphere for a defined system (such as political, territorial (per location), or other).

Carbon Pool – A reservoir of carbon that has the capacity to accumulate or release carbon. Carbon pools include above ground biomass, below ground 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.

Crediting Period – The time period for which GHG emission reductions or removals generated by the project are eligible for issuance as carbon credits.

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.

Ecological Leakage – Occurs when one ecosystem has an effect (positive or negative) on an adjacent ecosystem. An example is a protected forest that helps an adjacent forest stay healthy.

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 or bay where freshwater flows meet the sea.

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

GHG Inventory – see Carbon Inventory.

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 examples of landforms at different spatial scales.

Mangrove – 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.

Methodology – A specific set of criteria and procedures, which apply to specific project activities, for identifying the project boundary, determining the baseline scenario, demonstrating additionality, quantifying net GHG emission reductions and/or removals, and specifying the monitoring procedures.

Mineral Soil – Soil that does not have a surface layer of organic soil.

Organic Soil – Soil with a surface layer of material that has a sufficient depth and percentage of organic carbon to meet thresholds set by the IPCC (Wetlands supplement) for organic soil. Where used in this methodology, the term *peat* is used to refer to organic soil.

Proxy – A measured variable used to infer the value of a variable of interest. Under the VCS, proxies may be specified where it can be demonstrated that they are strongly correlated with the variable of interest. For example, water table depth may infer the amount of CO_2 emissions from peatlands.

Salinity Average – The average salinity value used to represent salinity in a given system.

Salinity Low Point – The minimum salinity value used to represent the minimum salinity during periods of peak CH_4 emissions (e.g., during the growing season in temperate ecosystems).

Seagrass Meadow – Seagrasses are flowering plants belonging to four plant families, all in the order *Alismatales*, which grow in marine, saline environments.

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 Wetland– The subset of wetlands under the influence of wetting and drying cycles of the tides, such as salt marshes, tidal freshwater marshes, forested tidal wetlands, and mangroves.

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

Vegetated Tidal Wetlands – Lands flooded by occasional or frequent tides supporting mangrove, tidal marsh, or seagrass plants.

Wetland–Land that is inundated or saturated by water for all or part of the year (e.g., peatland), at such frequency and duration that under natural conditions they support organisms adapted to poorly aerated and/or saturated soil. Wetlands (including peatlands) cut across the different AFOLU categories. Project activities may be specific to wetlands or may be combined with other AFOLU activities (VCS Program Definitions).

Key Messages

The following are key messages to help project developers prepare for developing a successful blue carbon project.

CARBON ASSET (CREDIT) GENERATION IN THE LAND–USE AND COASTAL WETLAND SECTORS

Carbon asset generation means the translation of greenhouse gas (GHG) emission reduction and sequestration activities into tradable 'carbon assets' or 'carbon credits', financing the carbon intervention (project) with cash. One credit represents **1 tonne (1.1 ton U.S.) of carbon dioxide (CO_2) equivalent** (tCO_2eq). Methane (CH_4) and nitrous oxide (N_2O) are converted to CO_2eq by their global warming potential.

There are a range of land use intervention categories – from agricultural land management to reforestation to reducing emissions from deforestation and forest degradation– recognized in voluntary carbon standards, most prominently the **Verified Carbon Standard (VCS)**, which has evolved as a global leader among standards, in particular concerning the land-use and coastal wetland sectors.

The most recently introduced intervention category under the VCS targets wetlands restoration and conservation (WRC) activities. The **WRC Requirements** offer comprehensive guidance for how to account for emission reductions across 'blue carbon' ecosystems, including mangroves, tidal and coastal wetlands, marshes, seagrasses, floodplains, deltas, and peatlands, and how to generate carbon assets to help with financing a project.

Carbon project development involves a wide range of technical, financial, and legal components. Given the recent adoption of the WRC Requirements and relevant methodologies, robust guidance has become available to lead through the process. Project development will not be simple and not be cheap: typical carbon development costs range from 100,000 to 300,000 USD (excluding long-term maintenance costs). Diligent preparations that include a **feasibility assessment** and, as the case may be, a **pre-feasibility assessment** to examine the general set of eligibility criteria and the availability of data and other resources, hence, is appropriate.

In most cases, **carbon finance** will not be enough to cover all associated costs of a wetland restoration projects. **Land tenure, use, and access rights**, in particular, can be expensive and require the availability of co-funding (in cash or in kind). Clear and transparent carbon development, in these cases, can help to **turn donors into investors** with a long-term commitment, to provide funders and the public with continuous **premium evaluation** of the merits (output of the project), and to produce exact figures for **policy makers on mitigation benefits**, abatement costs and longevity of the project.

WETLANDS RESTORATION AND CONSERVATION (WRC) UNDER THE VCS: KEY ELIGIBILITY CONSIDERATIONS

WRC projects cover both GHG emission reduction and sequestration projects within wetlands, whereby the standard aims at an open **definition of wetlands**, integrating international concepts derived from the IPCC or the Ramsar Convention as well as national ones.

A WRC project can be linked – within the same project – to other project categories such as **REDD+** or **ALM**.

WRC project activities range from rewetting and restoration (of degraded wetlands) to A/R (afforestation/reforestation) (of non-forested wetlands) and avoided drainage (of intact wetlands). The different activities may be combined in a single project (integrating activities from different categories or not).

All relevant GHG fluxes – CO_2, CH_4 and N_2O – are to be assessed using a VCS-approved GHG accounting methodology. Credit generation occurs when the project results in GHG emissions reductions and/or an increased carbon stock compared to what would have happened in the hypothetical "baseline" scenario. Various approaches to GHG accounting exist, including defaults, and proxies such as water table depth and carbon stocks change.

Measuring the GHG fluxes and projecting the **baseline scenario** (on the basis of projected carbon soil depletion timeframes, current and historic hydrological characteristics of the watershed or coastal plain, long-term average climate variables, risks of collapsing dikes or ditches, expected rises in relative water levels as a consequence of progressive subsidence of sediment, and so on) is the technically most complex part in a carbon project, and project developers need to rely on one or more approved methodologies to do so. Approved and pipeline methodologies can be viewed on the VCS website (http://www.v-c-s.org/methodologies) where a description of their applicability is provided.

In order to generate carbon assets/credits, project developers must also:

- Document the "**additionality**" of the project, i.e., that it would not be implemented in the absence of carbon finance, unless it is covered by a 'positive list' under the standardized procedures;
- Demonstrate **permanence**, i.e., the non-reversibility of carbon stock conservation and/or carbon sequestration output;
- Account for **leakage** emissions applying suitable methods; and
- Account for the effects of **sea-level rise**.

FIRST PROJECT STEPS: FEASIBILITY ASSESSMENT, SITE SELECTION, AND PRIORITIZATION

Coastal systems are naturally dynamic, subject to changes associated with climate change and sea-level rise as well as occasional disturbance events. Increased project resilience and reduced risk will be delivered by project implementation that accommodates, rather than attempts to resist, these natural processes. This is best achieved by maximizing natural environmental processes within the restoration activity.

Not all coastal wetlands are resilient to **sea-level rise** and as such will not make good individual candidates for carbon projects. This should be evaluated within the **feasibility assessment** and recognized within the risk analysis.

Planning blue carbon projects at the scale of **landscape change** (e.g., whole estuary, linking up to adjacent river floodplains and uplands) provides an opportunity to reduce overall risk to project outcomes, recognizing uncertainty in climate change and other human pressures.

An anticipated bottleneck to wetlands carbon projects moving forward is the absence of regional quantification of baseline GHG fluxes (including carbon stock changes) on former coastal wetlands. **Regional quantification** of GHG fluxes would offer important support for programmatic carbon project and policy planning.In the U.S., but also elsewhere, federal (or national) and state (or regional) agencies may be well placed to provide coherent science programs from which private or public sector individual blue carbon projects or programs may develop.

Such engagement would provide a template for project proponents and reduce project set up costs.

Models (global and regional) projecting coastal wetland building or drowning with respect to **sea-level rise**, and associated carbon sequestration are now in a refined state of development and accessible to project developers. Though relationships relating methane emissions to salinity have been developed, models describing methane emissions from coastal wetlands are still in research and development.

USING THE METHODOLOGY FOR TIDAL WETLAND AND SEAGRASS RESTORATION

The VCS Methodology for Tidal Wetland and Seagrass Restoration (referred to herein as 'the **Methodology**') provides a broad and flexible framework for the accounting of GHGs from the diversity of coastal wetland landscapes across the spectrum of restoration and creation practices.

Project eligibility is determined by meeting a set of applicability conditions that are designed to provide the scope of restoration activities, avoid projects that cause leakage, and avoid other negative effects of project activities.

For projects seeking credits for avoided carbon losses (instead of or in addition to carbon sequestration), the depletion of soil organic matter in the baseline scenario must be assessed, after which point in time GHG emissions will stop and a project cannot claim emission reduction. Therefore, the peat depletion time (PDT) and/or the soil organic carbon depletion time (SDT) are important additional aspects of the **temporal boundary** of a blue carbon project.

When determining **geographical project boundaries**, projects must assess relative sea-level rise and the potential for expanding the project area landward to account for wetland migration, inundation, and erosion.

The Methodology includes an approach to **additionality** that deems all tidal wetland and seagrass restoration projects occurring in the U.S. as additional. Projects outside the U.S. must follow the traditional procedures, captured in tools or modules.

A range of **accounting methods** are given to quantify GHGs, including default values, emission factors, published values, models, proxies, and field-collected data. Collecting large amounts of field-collected data will significantly increase project costs. **Models and proxies** are not yet available for many emission scenarios; their development is a significant research need. A feasibility assessment should therefore include monitoring costs.

Projects with **avoided losses** (prevention of soil organic carbon oxidation) are among the projects with the greatest potential to generate blue carbon credits. The Methodology provides guidelines for determining avoided losses for both organic and mineral soils.

Soil carbon sequestration is a significant and continuing CO_2 emission reduction in coastal wetlands. The Methodology provides a default value for non-seagrass tidal wetlands that may be used in the absence of published data.

Projects with mineral soils need to determine a deduction from the soil carbon sequestration rate to account for **allochthonous carbon**. The simplest option is to collect field samples on the carbon percentage of project soils, which is then combined with default values for other variables to estimate the deduction.

Methane emissions are a significant challenge for projects conducted in fresh and brackish systems (salinity < 18 ppt) because there is no default value available and validated, and published models or proxies are not yet available. The development and validation of models and proxies to estimate methane emissions from fresh and brackish tidal wetlands is among the greatest challenges facing the research community over the coming decades to facilitate the adoption of blue carbon crediting. Until these models and proxies are developed, project developers may use published or field-collected data for projects in these systems.

Nitrous oxide emissions only need to be accounted for in the project scenario in cases where the water table is lowered; for such projects default values are provided in the Methodology or it may be demonstrated to the validator that N_2O emissions are not increased by the project.

The Methodology requires that the project developer demonstrates (through a set of applicability conditions) that productive activities are not being displaced from the project area and therefore the **absence of leakage**. There is no accounting procedure for leakage as such.

GROUPED PROJECTS: APPLICABILITY AND RECOMMENDATIONS

Wetland restoration planning has evolved from planning individual projects to enacting **large grouped projects** (structured to allow the gradual geographic expansion of a project activity) of tens of thousands of acres in size involving multiple smaller projects. This approach is to maximize wetland recovery across the landscape, increase resilience to climate change and recognize economic as well as other benefits of coordinated planning. Subject to case-by-case evaluation, a firm technical, legal, and institutional basis may be found for developing large-scale grouped coastal wetland carbon projects.

Introduction: Blue Carbon and Blue Carbon Finance

The opportunity for ecosystem conservation and restoration to generate emission reductions and to achieve carbon finance is significant, in particular for wetlands conservation. About one quarter of all human-induced emissions come from agriculture, forestry, and other land-use (AFOLU), with a substantial contribution from drained wetlands and degraded coastal habitats (Crooks et al. 2011; Donato et al. 2011; Pendleton et al. 2012). Regulators at the national and at the international level are taking note. Recently, the Intergovernmental Panel on Climate Change (IPCC) produced a wetlands supplement, which includes a dedicated section on carbon accounting for emissions from conversion and drainage of coastal wetlands (IPCC 2014).

Direct cap-and-trade coverage, i.e., the adoption of a GHG emissions cap imposed on landowners or land-users, is not likely in the short term (New Zealand being a notable international exception). However, indirect coverage – emission reductions and GHG sequestration efforts from ecosystems feeding into a cap-and-trade system – is an increasingly realistic option. Conservationists seeking funding (or perhaps only guidance for project implementation) are encouraged to assess the opportunity to monetize the emission reduction benefits of their projects.

Coastal blue carbon has emerged as a carbon finance tool in its own right. Blue carbon intervention refers to the ability of coastal wetland ecosystems - mangroves, tidal marshes, and seagrasses - to sequester and store carbon dioxide (CO_2) (IUCN 2009),[1] but it is appropriate to extend the term to additional emissions from these systems, namely of methane (CH_4) and nitrous oxide (N_2O). Due to wetland habitat destruction and land use change, carbon that has been stored for centuries in the soil is being released back into the atmosphere. An estimated half a billion tonnes (450×10^6 t) of CO_2eq (Pendleton et al. 2012) is being released per year (equal to the 2008 emissions of Japan), meanwhile habitat loss continues to occur at a dramatic scale. If additional measures are not taken, at current rates the world's coastal wetlands will disappear within the next 100 years (Pendleton et al. 2012). Coastal habitats are undergoing stress in both developing and industrialized countries from coastal urbanization, agriculture (both on land and in water), waterway planning, tourism, as well as accelerating sea-level rise.

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[1] *IUCN, Gland, Switzerland. 53 pp*

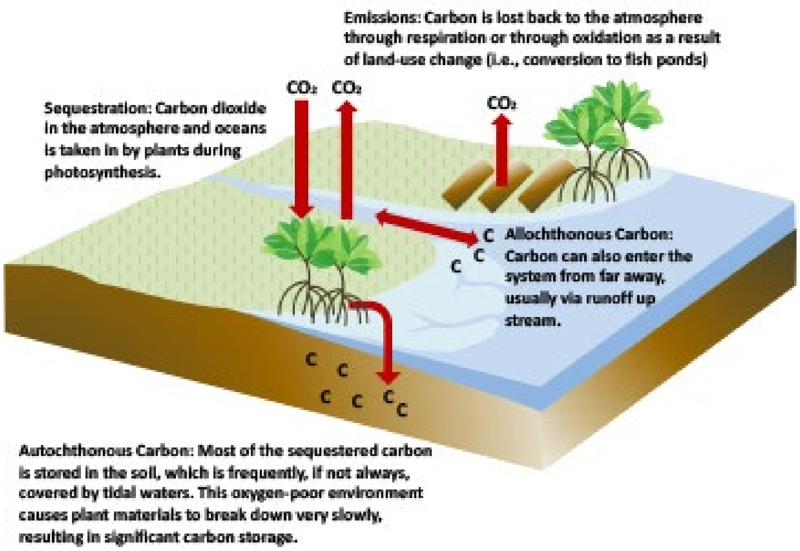


Figure 1: Mechanisms by which carbon moves into and out of tidal wetlands. Source: Howard et al. 2014.

Due to the ongoing decline of coastal wetland habitats, conservation and restoration have been recognized as policy priorities long before the CO_2 impact of degradation had been discussed, let alone addressed through carbon finance incentives. Stabilized wetlands help cushion the impact of both droughts and floods and are important factors in the provision of arable land and drinking water. In many countries, including the U.S., wetlands are protected by law. However, deterioration is mostly a slow process, due to growing human encroachment and sea-level rise. History has shown that existing protection regimes are often too weak or too poorly enforced to be effective. Restoration requires additional (sometimes costly) effort, which is rarely dictated by law. The U.S., for example, in most places has a 'no net loss' policy in place, and yet according to estimates has lost between 60,000 and 80,000 acres of coastal wetlands annually between 1998 and 2009 (Stutz 2014).

Conservation project activities generate GHG emission reductions through:

- Avoided loss of biomass;
- Avoided loss of soil organic carbon; and
- Avoided increase of methane and/or nitrous oxide emissions due to decreased salinity or changing land use.

Conservation project activities avoid the degradation of wetlands caused by drainage, impoundment, or the interruption of sediment supply.

Restoration project activities generate GHG emission reductions and removals through:

- Increased biomass;
- Increased autochthonous soil organic carbon;
- Reduced methane and/or nitrous oxide emissions due to increased salinity or changing land use; and
- Reduced carbon dioxide emissions due to avoided further soil carbon loss.

Restoration project activities include the following:

- Removing tidal barriers;
- Improving hydrological connectivity;
- Restoring tidal flow to wetlands;
- Lowering water levels on impounded wetlands;
- Beneficial use of dredge material;
- Diverting river sediments to sediment-starved areas;
- Restoring tidal flow to tidally-restricted areas;
- Reducing nutrient loads leading to improved water clarity to expand seagrass meadows;
- Recovering tidal and other hydrologic flushing and exchange;
- Reducing nutrient residence time;
- Reseeding or replanting of native plant communities; and
- Combinations of the above.

The blue carbon finance cycle provides an additional incentive for landowners, other users, governments, and civil society to enhance conservation and restoration measures. The incentive is foremost a financial one, but it goes beyond this. **Blue carbon standards offer a blueprint for numerous project activities, best practice guidance, and a platform for scientific, technical, and policy-related exchange.** Furthermore, blue carbon is an important tool to measure and verify the environmental benefit any conservation or restoration activity yields.

With this Manual, we present first an overview of carbon projects and carbon asset generation with a particular regard for AFOLU projects and blue carbon precedents

(II.). We then explain the key elements of the world's leading standard for wetland restoration and conservation (WRC) activities under the Verified Carbon Standard (VCS) (III.). We develop a number of best practices for project planning and a project feasibility assessment (IV.), before highlighting the main stages of carbon accounting in the Methodology (VM0033) (V.), and the carbon project cycle process (VI.). We close the Manual with concrete recommendations for carbon asset management, contracts and marketing choices (VII.), and an overview of grouped projects (VIII.).

When using this Manual, existing documents that provide a basis for the development of a carbon project should be reviewed. The following publications provide a helpful review of the more general principles and common procedures:

- Guiding Principles for Delivering Coastal Wetland Carbon Projects (UNEP and CIFOR 2014);
- Building Forest Carbon Projects: Step-by-Step Overview and Guide (Olander and Ebeling 2011); and
- Project Developer's Guidebook to VCS REDD Methodologies, Version 2.0 (Shoch et al. 2013)–Sections 2 and 3.

Since this Manual focuses on coastal wetlands-related issues, documents to be read for a complete understanding of carbon project development alongside this Manual are the following:

- VCS Standard and VCS AFOLU Requirements, at www.v-c-s.org/program-documents;
- VCS Program Definitions, at www.v-c-s.org/program-documents; and
- AFOLU Non-Permanence Risk Tool, at www.v-c-s.org/program-documents.

This Manual looks into aspects of carbon project development and investment relevant for blue carbon and thereby attempts to close an important, previously noted (Thomas 2014) knowledge gap.

For illustrative purposes, we chose to apply selected subjects to a recently developed U.S. estuary-scale coastal wetland carbon assessment, located in the Snohomish Estuary, Washington State, and to the San Francisco Bay estuary. As there are no current blue carbon projects to draw from, we provide these 'case studies' as a way to illustrate the thought process for project development. These case studies are denoted in subset boxes throughout the text.

II.

Background: Carbon Asset Generation in the Land–Use and Coastal Wetland Sectors

Emissions trading and carbon asset generation have their origins in modern environmental policy making. The U.S. pioneered these ideas, when in 1990 it created a trading platform for air pollutants with the adoption of its 'acid deposition control' policy, which aimed at reducing sulphur dioxide (SO_2) emissions.[2] A few years later, the U.S. was among the countries that promoted the development of an international emissions trading mechanism for the Kyoto Protocol, and it also spearheaded emissions trading within the national context. The basic idea is that a jurisdiction puts sector-wide caps on GHG emissions and issues permits or allowances to economic operators. The operators may only emit greenhouse gases in a given 'compliance year' if the relevant amount is backed by an equivalent number of permits or allowances (accounted for in tonnes of CO_2 equivalent (tCO_2eq) by which CH_4 and N_2O are converted to CO_2 by their global warming potential). The existing U.S. schemes include California's cap & trade scheme enacted through the Global Warming Solutions Act under Assembly Bill 32 (known as 'AB 32') and the Regional Greenhouse Gas Initiative ('RGGI').

1. ACCOUNTING FOR LAND–BASED EMISSIONS

Cap & trade was primarily designed for industrial and fossil fuel based emissions. The European Union's emissions trading scheme is the biggest in the world, comprising some 30 countries and 2 billion tCO_2eq per year, and includes some 11,000 emissions sources. The emissions are comparably easy to measure and verify, and are fairly constant. Though there is some variability, overall industry emissions follow controlled and traceable emission patterns and trends. This does not hold true for land and vegetation based emissions, which are everywhere (all vegetation and soils are potential sources), subtle, subject to fluctuations, and hard to control, at least over longer periods of time. In addition, land and vegetation are dynamic: they emit GHG, but they also act as a GHG sinks and store GHG over time. Thus, to many it was little surprise that the Kyoto Protocol – the first (and still only) international treaty to define absolute emissions targets for a range of countries – largely avoided dealing with the complex

[2] *Title IV of the 1990 Clean Air Act Amendments Pub. L. No. 101-549, 104 Stat. 2399 (codified as amended at 42 U.S.C. 7401-671 (1994)).*

matter of land and vegetation based emissions. Of all land and vegetation activities types, only net changes in forest cover (afforestation, reforestation, and deforestation) since 1990 were made a mandatory part of a country's accounting system (Article 3.3 Kyoto Protocol). For a handful of other land-activity types – revegetation, forest management (FM), cropland management (CM), grazing land management (GM), and more recently wetland drainage and restoration (WDR) – countries have the *option* to include them in their accounting systems (Article 3.4 Kyoto Protocol).[3] Virtually none have chosen the 'opt-in' during the first commitment period (Denmark being the notable exception).

2. NEW APPROACHES

Despite the lack of attention from the Kyoto framework, AFOLU project developers have not been idle. Outside the regulated Kyoto markets —the Clean Development Mechanism (CDM) and Joint Implementation (JI) – project development under **voluntary standards**, i.e., non-government self-regulations, has spread. All of the leading standards – the Verified Carbon Standard (VCS), the Climate Action Reserve (CAR), the American Carbon Registry (ACR), and the Gold Standard (GS) – have created dedicated project type activities. These range from fertilizer management, grassland farm techniques, and livestock and manure management to improved forest management, mangrove reforestation, reducing emissions from deforestation and forest degradation (REDD), and wetland restoration. To date, 45% of the voluntary market transaction volume (CO_2eq credits sold) relate to projects in the forestry and land use sector.

[3] *In conjunction with Decision 16/CMP.1, Annex, para 6; and Decision 2/CMP.7, Annex, para. 6.*

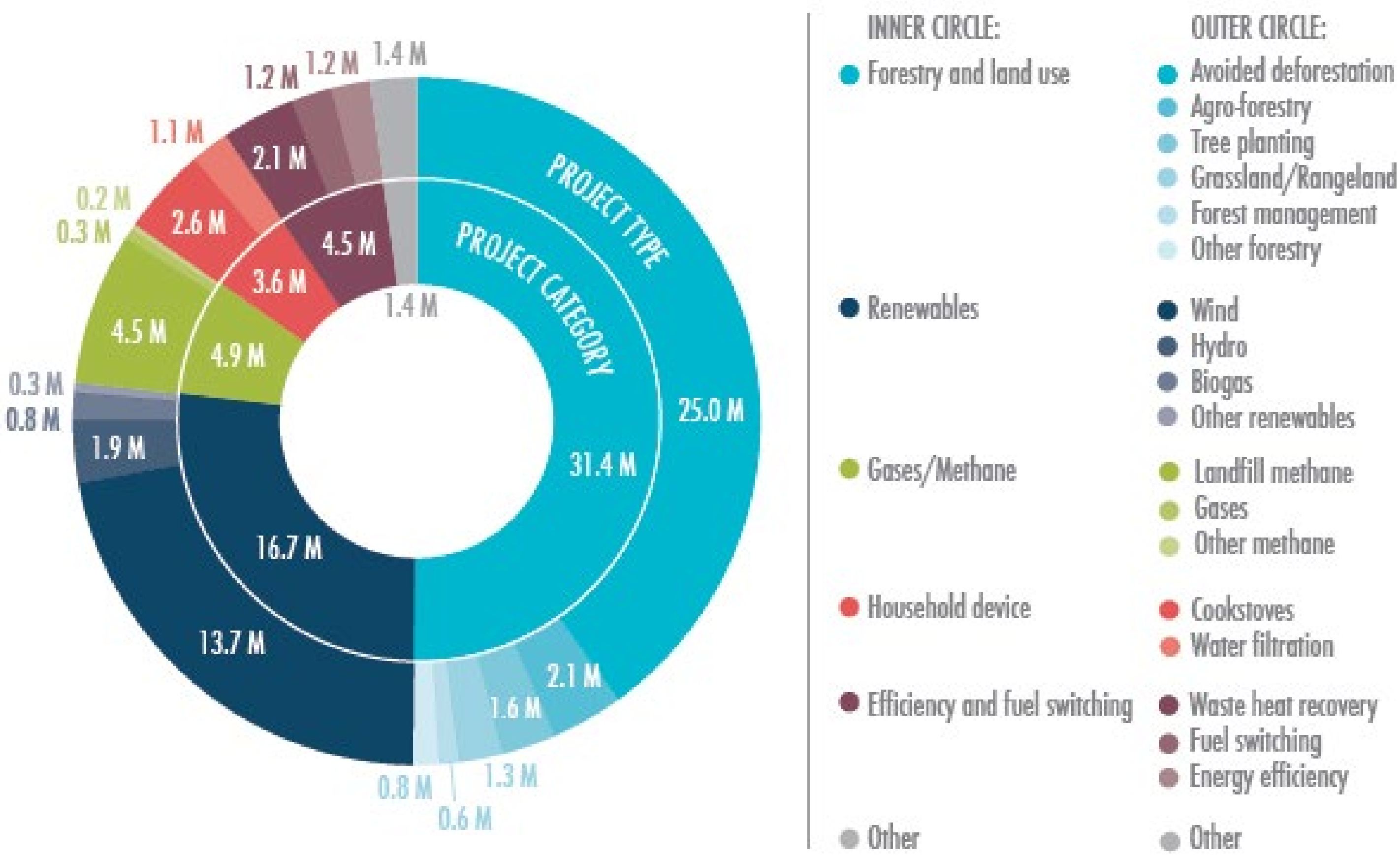


Figure 2. Transaction volume by project category and type in 2014. Source: Forest Trends' Ecosystem Marketplace. State of the Voluntary Carbon Markets 2015.

The VCS has become the largest of the four leading standards (see figure 3), with close to 1,200 projects worldwide (70 of which are located in the U.S.) and more than 150 million credits issued to date. In its sectoral scope 'Agriculture and Forestry' (which excludes livestock and manure management, a category of its own) the VCS recognizes six project categories:

- Afforestation, Reforestation, and Revegetation (ARR);
- Agricultural Land Management (ALM);
- Improved Forest Management (IFM);
- Reduced Emissions from Deforestation and Degradation (REDD);
- Avoided Conversion of Grasslands and Shrublands (ACoGS); and
- Wetlands Restoration and Conservation (WRC).

At the end of 2014, 94 projects were registered under the 6 categories combined (6 of which located in the U.S.). Most projects anticipate a four- or five-digit annual emissions reduction (or sequestration) rate, but certain REDD projects are large, generating up to a million offset units – known as Verified Carbon Units or VCUs – a year.

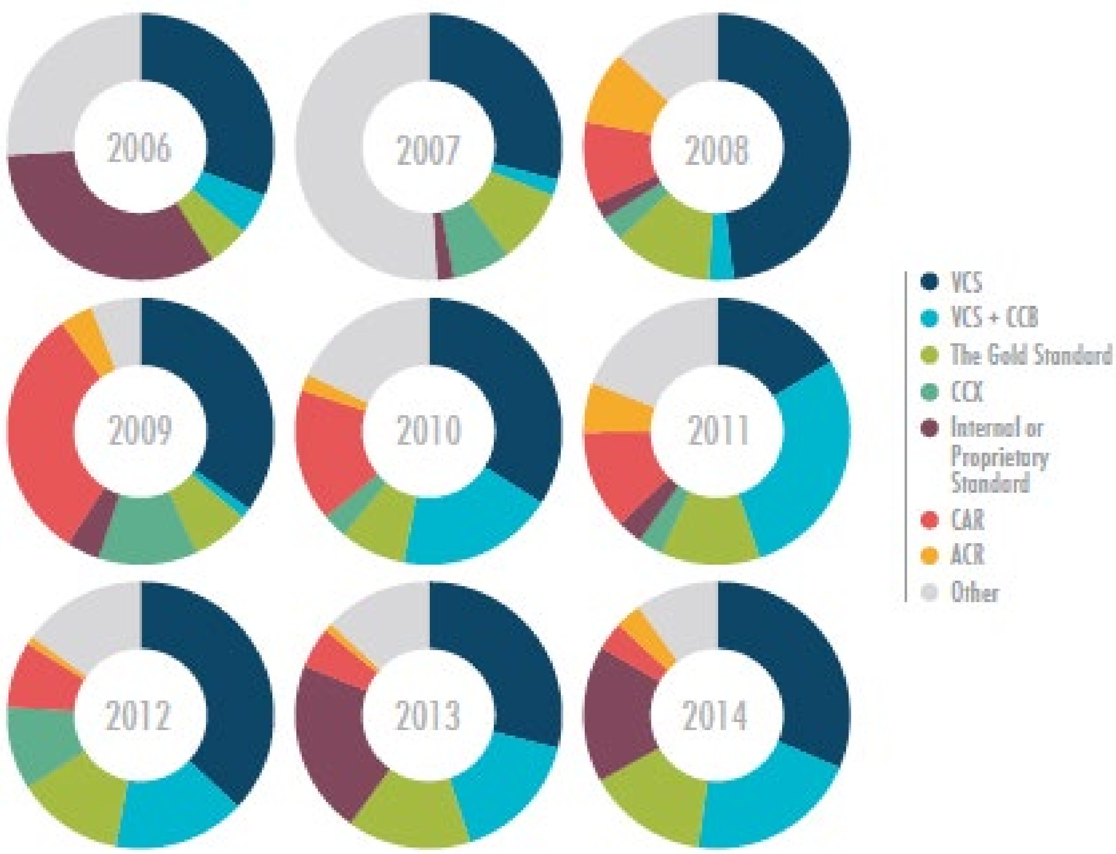


Figure 3. Standard market share by volume, 2006-2014. Source: Forest Trends' Ecosystem Marketplace. State of the Voluntary Carbon Markets 2015.

The WRC category is the most recent project category. It offers comprehensive guidance for how to account for emission reductions across 'blue carbon' ecosystems, including mangroves, tidal and coastal wetlands, marshes, seagrasses, floodplains, deltas, and peatlands.

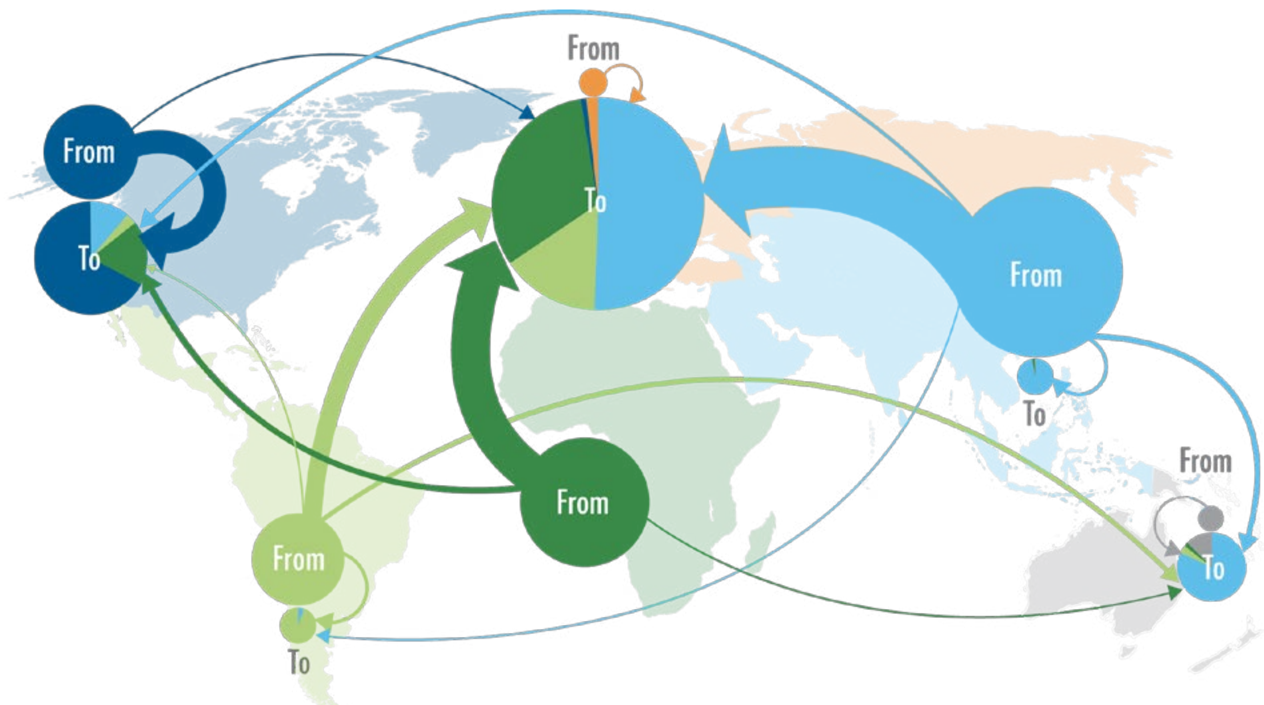
The ACR is a smaller standard but has a strong U.S. presence (in particular for carbon capture and storage, landfill gas, and transport projects). Its project database shows more than a hundred projects – some in the agricultural and forestry sectors – with a total issued credit amount of some 40 million credits so far. Among its roughly 25 recognized methodologies, one has been developed with a (regional) blue carbon focus ('Restoration of Deltaic Wetlands of the Mississippi Delta'), and one on 'California Deltaic and Coastal Wetland Restoration' is under development. At the time of writing, projects had not yet registered under either methodology.

CAR is restricted to projects in the U.S. and in Mexico, but is comparably strong in project numbers and carbon output. It includes more than 350 projects, including forestry projects (reforestation, avoided conversion, improved forest management) and urban forest projects. However, CAR does not consider projects on public lands to be 'additional' (for more on 'additionality' requirements, see chapter V.4). CAR grew out of a California based initiative, and its presence in California – in particular for forestry projects – remains strong. So far, CAR has not engaged in any wetland related activities.

The Gold Standard (GS) hosts more than 200 registered projects with a to-date credit value of 20 million USD. Forestry and land use (Afforestation/Reforestation), climate smart agriculture and improved forest management have been adopted as eligible project sectors only recently. The A/R project type has a specific window for mangroves, but there has been no registration activity yet.

To a certain extent, the various standards do interact. All of them are open to methodologies accepted under the CDM. The VCS furthermore accepts any methodology developed under CAR (with the notable exception of CAR's forest protocol), and vice versa.

All standards have high market recognition, even though certain aspects of trading make it hard to trace the details of all transactions (i.e., most transactions are over-the-counter (OTC) with a diverse global market distribution (see figure 4) and no central reporting or disclosure framework).



From ↓ To →	Europe	North America	Oceania	Latin America	Asia
Asia	12.8 M	0.8 M	2.2 M	0.04 M	0.7 M
Latin America	3.8 M	0.2 M	1 M	0.7 M	0.01 M
Africa	8.1 M	1.3 M	0.5 M	-	0.01 M
North America	0.2 M	4.8 M	-	-	-
Oceania	0.01 M	0.01 M	0.3 M	-	-
Europe	0.4 M	-	-	-	-

*Values smaller than 0.1 Million (M) are not shown on map.

Figure 4. Flow of transacted volume from supplier to buyer region (2007-2013). Source: Forest Trends' Ecosystem Marketplace. State of the Voluntary Carbon Market 2014.

Credit pricing remains complex, as the offset market is not fully commoditized. That means, prices do not only differ between the different standards but also (intensely) between project categories. The average price paid in 2014, as reported by Forest Trends, was 3.8 USD, but prices for credits from wind projects were considerably lower than the average and prices for a range of AFOLU activities considerably higher. For the VCS it should be noted that premium registration – under the VCS and, in parallel, under the Climate, Community, and Biodiversity Alliance (CCBA) – adds more than two USD in average to the credit price (Forest Trends 2015).

At the same time, the emergence of REDD credits has for the first time led to an oversupplied market, in which a growing number of projects do not find a buyer. The question is whether blue carbon – which includes a number of highly carbon-intensive project categories – risks going along the same path. The question will remain hypothetical for some time – at least as long as the number of blue carbon projects continues to be small. Yet, even under a scenario of large blue carbon credit supply it may be easier for many blue carbon projects to attract buyers at an appropriate price than for REDD developers. First, blue carbon is not confined to developing countries. Coastal wetlands and marshlands exist in the northern hemisphere as well as in the southern one. Given the fact that most buyers of carbon credits are in the West and that there is a noticeable (and growing) market preference for domestic credits – California's AB 32 is a telling example – wetland projects in North America, Europe, Japan, etc. are likely to do well in the markets of the future. Secondly,blue carbon projects have a myriad of co-benefits, including their capacity to improve water quality, to fortify sustainable agricultural land, to provide habitat, and to protect coastline from the effects of extreme weather and sea-level rise. These co-benefits make blue carbon project activities a key priority for governments and business, as these ecosystem services are more concrete than climate change and global warming as a whole. This linkage should help market blue carbon credits across economies.

In the following, we will review the eligibility considerations for a blue carbon project. Given its size and dedication to blue carbon activities, we will use the WRC guidance under the VCS as our guiding standard document to explain key project development phases, challenges, and opportunities.

III.

Wetlands Restoration and Conservation under the VCS: Key Eligibility Considerations

WRC projects under the VCS cover both emission reductions and sequestration activities, as they are related to holding carbon or avoiding the degradation of wetlands, or to restoring wetland ecosystems. The concept of "wetlands" is a broad one: It covers all locations fitting the definition of "wetland" used by international organizations (such as the Intergovernmental Panel on Climate Change (IPCC) or the Ramsar Convention on Wetlands), national law or policy, or as agreed in the peer-reviewed scientific literature. Wetlands include peatland, salt marsh, tidal freshwater marsh, mangroves, wet floodplain forests, prairie potholes, and seagrass meadows. The WRC scope is not exclusive or competing with other project categories, i.e., a project can both have a REDD and a wetlands component or an ALM and a wetland component, and so on. When combined, the developer can apply different methodologies for the different parts, while ensuring that GHG removals or emission reductions are not accounted for twice. The recognized project activities are shown in table 1.

Table 1. Blue carbon interventions and project categories recognized under the VCS standard. Source: Verified Carbon Standard.

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	RWE
		Restoring wetlands and revegetation or conversion to forest	RWE+ARR
		Restoring wetlands and conversion to wetland agriculture (including paludiculture)	RWE+ALM
		Restoring wetlands and avoided conversion of grassland or shrubland	RWE+ACoGS
	Forest	Restoring wetlands	RWE
	Forest with deforestation/ degradation	Restoring wetlands and avoided deforestation	RWE+REDD
	Forest managed for wood products	Restoring wetlands 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

ACoGs: Avoided Conversion of Grasslands and Shrublands

ALM: Agricultural Land Management

ARR: Afforestation, Reforestation and Revegetation

CIW: Conservation of Intact Wetlands

IFM: Improved Forest Management

REDD: Reducing Emissions from Deforestation and forest Degradation

RWE: Restoration of Wetland Ecosystems

Projects may incorporate multiple project activities. For example, a project may be a combination of conservation and restoration, or a combination of mangrove restoration by replanting and marsh restoration by removing dams. The project area does not need to be a single contiguous area but can be composed of dispersed patches of land. It can also be set up as a 'grouped project', which allows for the inclusion of future locations not yet known or not yet accurately demarcated (see more about project grouping in chapter 8).

All relevant GHG fluxes – CO_2, CH_4, and N_2O – are to be assessed using a VCS-approved GHG accounting methodology. Credit generation occurs when emissions are lower or removals are higher than would have happened in the hypothetical "baseline" (without project) scenario.

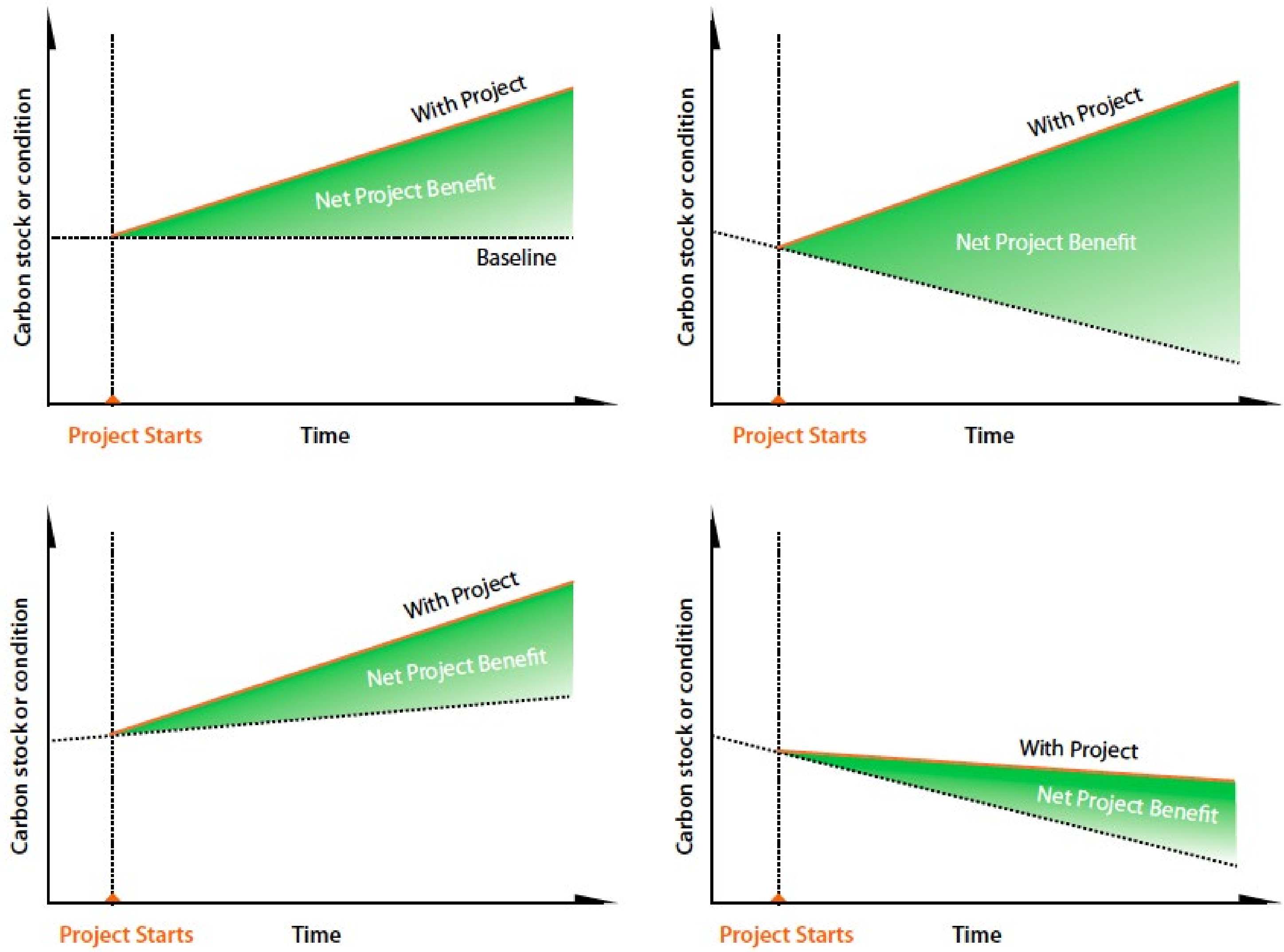


Figure 5. Various scenarios for net project benefits of restoration projects on carbon stocks. Source: Olander & Ebeling 2011.

Figure 5 provides hypothetical illustrations of scenarios demonstrating net benefits of carbon projects, further discussed in Crooks et al. 2014.

The process of carbon asset generation for a VCS project:

Measuring the GHG fluxes and projecting the baseline scenario (on the basis of projected carbon soil depletion timeframes, current and historic hydrological characteristics of the watershed or coastal plain, long-term average climate variables, risks of collapsing dikes or ditches, expected rises in relative water levels as a consequence of progressive subsidence of sediment, and so on) is the technically most complex part in a carbon project, and project developers need to rely on one or more approved methodologies to do so (see chapter 5). Four peatland-related methodologies (three for tropical regions and one for temperate climates) are currently approved or under validation by the VCS, while one tidal wetlands restoration methodology (VM0033) has been approved, and a REDD+ methodology covering the restoration and conservation of tidal wetlands forthcoming.

The results of the assessment of both 'project scenario' and 'baseline scenario' for the defined project site need to be documented in the "Project Document" or "PD" and validated by a third-party expert ("validation").

Project developers do not need to wait for the preparation or validation of the PD before starting to implement the project. However, if they do start with implementation, they need to ensure that the project is appropriately monitored (in line with the methodology used) from the moment crediting is sought. Also, pre-registration crediting is only allowed in a timeframe of five years at most, i.e., projects must be validated within five years of starting.

Specific challenges for project development and crediting are presented by the following (see chapter 5 for discussion):

- **Additionality:** A project developer needs to show that the project is more than business-as usual and would not happen without 'additional' finance from carbon offset generation. Under existing additionality tools (CDM tool Combined tool[4] to identify the baseline scenario and demonstrate additionality for A/R CDM project activities; VCS Tool for the Demonstration and Assessment of Additionality in VCS AFOLU Projects), a three-step approach needs to be followed:
    - Step 1:Identify alternative baseline (without project) land use scenarios and make a convincing argument that the selected baseline scenario is the most likely scenario among potential alternative scenarios;
    - Step 2*:* Show that either lack of investment or other barriers (of the technological, institutional, social,or other) stand between the baseline scenario and the project scenario; and
    - Step 3: Show that the envisaged project activities are not common practice in the project region, discounting any other carbon activities in the absence of carbon incentives.

  For a project to be considered additional, it must also meet the regulatory surplus test, which means it cannot be required by any (enforced) law, statute or regulatory framework.

  The Methodology for Tidal Wetland and Seagrass Restoration (VM0033)also uses an alternate –standardized– approach to demonstrate additionality, and eases the burden of proof on the project developer (more on additionality in chapter 5.4). The rationale for the standardized approach is to encourage project activities that are infrequently implemented when compared to their maximum adoption potential, and to streamline project development and the assessment process for individual projects.

- **Longevity and permanence:** A project developer needs to show that project activities will be maintained for a minimum of 30 years. The VCS has produced an elaborate AFOLU Non-Permanence Risk Tool to assess the risk of a potential loss in carbon stock in the project over a period of 100 years; for projected longevities of less than 30 years, the risk is deemed too high to warrant project registration in the first place. The longevity exclusion threshold and, in fact, the concept of non-permanence applied to emission reduction activities (as opposed to emission sink removal activities) as

[4] *Clean Development Mechanism Combined Tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities; https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf/history_view*

a whole have given rise to much debate,[5] and the VCS may yet change its related rule set. At the time of writing, however, the Non-Permanence Risk Tool is applied to emission reduction and sink projects without discrimination.

- **Leakage:** A project developer needs to either show that the project does not lead to an increase in emissions or decrease in removals of GHGs outside the project area, or account for this leakage. Examples of types of leakage can be seen in table 2.

Table 2. Leakage types with examples and how to overcome leakage issues.

LEAKAGE TYPE	EXAMPLE	HOW TO OVERCOME
Ecological	The project may lead to changing water tables or a disruption of sediment supply, negatively affecting outside the project area.	Need a location-tailored technical response (e.g., establishing a buffer zone or avoiding water leakages by proper site selection and project design)
Activity-shifting	The disturbance (e.g., agriculture on drained wetlands) is taken up outside the project area.	Community benefits achieved through the project (e.g., jobs)
Market-effects	Market demand for products from the project area remains the same and supply shifts.	Goods replacement (e.g., sustainable shrimp farming)

For coastal wetlands, specific challenges (for which methodological solutions are provided in the Methodology and discussed in chapter 5) include:

- **Accounting for sea-level rise:** Sea-level rise is a threat to carbon-based wetland restoration and conservation projects in that carbon stocks in accumulated biomass may be lost along with ongoing sequestration potential if the intertidal wetland drowns. When determining the 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.
- **Setting additional temporal boundaries:** Once depletion of soil organic matter in the baseline scenario is reached, GHG emissions will stop; a project cannot claim avoided loss emission reductions beyond this point in time. The project therefore needs to assess the peat depletion time (PDT) and/or the soil organic carbon depletion time (SDT) in the baseline scenario.

[5] *For a critical assessment see von Unger, M. / Emmer, I. / Joosten, H. / Couwenberg, J., Carbon Market Approaches for Peatlands and Forests (to be released shortly); see further Skutsch, M./Trines, E., Understanding permanence in REDD, K:TGAL Policy Paper No 6 (June 2010), accessible at http://www.communitycarbonforestry.org/NewPublications/KTGAL%20Policy%20 Note%206%20Permanance%20in%20REDD.pdf; Myers, E., Policies to Reduce Emissions from Deforestation and Degradation (REDD) in Developing Countries, , Resources for the Future (2008), accessible at http://www.rff.org/RFF/Documents/RFF-Rpt-REDD_final.2.20.09.PDF; Alvarado, L./Wertz-Kanounnikoff, S., Why are we seeing "REDD"? An analysis of the international debate on reducing emissions from deforestation and degradation in developing countries, IDDRI 2/2007, accessible at http://www.iddri.org/Publications/Collections/Analyses/An_0702_Rubio&Wertz_REDD.pdf; Potvin, C./Guay, B./Pedroni, L., Is reducing emissions from deforestation financially feasible? A Panamanian case study, Climate Policy 8 (2008) 23-40.*

- **Distinguishing allochthonous and autochthonous soil organic carbon:** Distinguishing carbon stock changes as a result of the on-site accumulation of allochthonous and autochthonous soil organic carbon, where accumulation of allochthonous cannot in all circumstances be accounted towards the carbon benefits of the project.
- **Quantification and prediction of carbon loss from the wetland ecosystem and the fate of that carbon:** When soil erodes due to sea-level rise, the eroded carbon may eventually be re-buried and therefore protected, or it oxidizes and is a GHG emission. Carbon that is lost from the project boundary in the baseline scenario but not mineralized and emitted cannot automatically be claimed as an emission reduction if the project protects that soil carbon. With the current state of scientific knowledge, the quantification of oxidation coefficients is a great challenge affecting the carbon credit output of a project to a great deal.

SUMMARY OF KEY CHARACTERISTICS FOR
WETLAND RESTORATION AND CONSERVATION CARBON ACTIVITIES

- Projects may incorporate multiple project activities. (See table 1)
- All relevant GHGs must be assessed: CH_4, CO_2, and N_2O.
- Credits are generated when project activities result in decreased emissions and/or increased carbon storage that is more than the baseline scenario would have yielded.
- Measuring GHG fluxes is technical and complex. Developers must rely on one or more approved methodologies to do so.
- Before implementing a project, the results from assessing the (1) project scenario and (2) baseline scenario must be documented in the Project Document (PD) and validated by a 3rd party.
- Projects must address issues of: additionality, longevity and permanence, leakage, and, where appropriate, sea-level rise.

Box 1. Snohomish Estuary: Background andVCS Eligibility

The Snohomish Estuary represents a typical coastal system for the Pacific Northwest Region in the U.S. It is the second largest Puget Sound drainage at 4,807 km^2. Pre-1930, the landscape comprised a continuum of wetlands from forested river floodplains to tidally influenced forested floodplains, giving way to scrub-shrub, vegetated emergent wetlands and, at the mouth, unvegetated tidal flats. Around the 1930s, dikes were built along the course of the river and channels, forests and other vegetation were cleared and the wetlands drained. These drained lands are now subsided below sea level, reflecting both the release of carbon when the soils were drained but also soil compaction with drainage. Only 16% of former wetland area remains as tidally connected wetland.

The potential for restoration of emergent wetlands is very good, demonstrated by the presence of one large naturally restored site (Ebey Island: dikes breached during a flood event in the 1960s) along with several large restoration projects either enacted over the past 15 years or in the late stages of planning and construction.

Though no carbon project has been planned for the estuary, the Snohomish system, supported by recent studies, does lend itself as a case study to illustrate the information and thought processes that would inform carbon project development. The reader is also directed to a recent research project that quantified the emissions when the estuarine wetlands were drained and the potential carbon sequestration with planned wetlands restoration under existing sea level and with a rise in sea level of one meter over coming decades (Crooks et al. 2014). The study included the quantification of potential carbon sequestration with restoration of the wider floodplain, including reaches that would become tidal with one meter of sea-level rise. The results are summarized in table 3.

Projects such as the one in the Snohomish estuary have the potential to be eligible for application under the VCS. Factoring in GHG emissions and removals under baseline conditions and how the system will respond to sea-level rise are important components of project development and planning. The study also illustrates that wetland restoration projects tend to be piecemeal in development. Each of the described projects were owned and enacted by different, but sometimes overlapping partners. The estuary is not being restored as a single project but as a series of smaller individual projects (see chapter 8 on grouping).

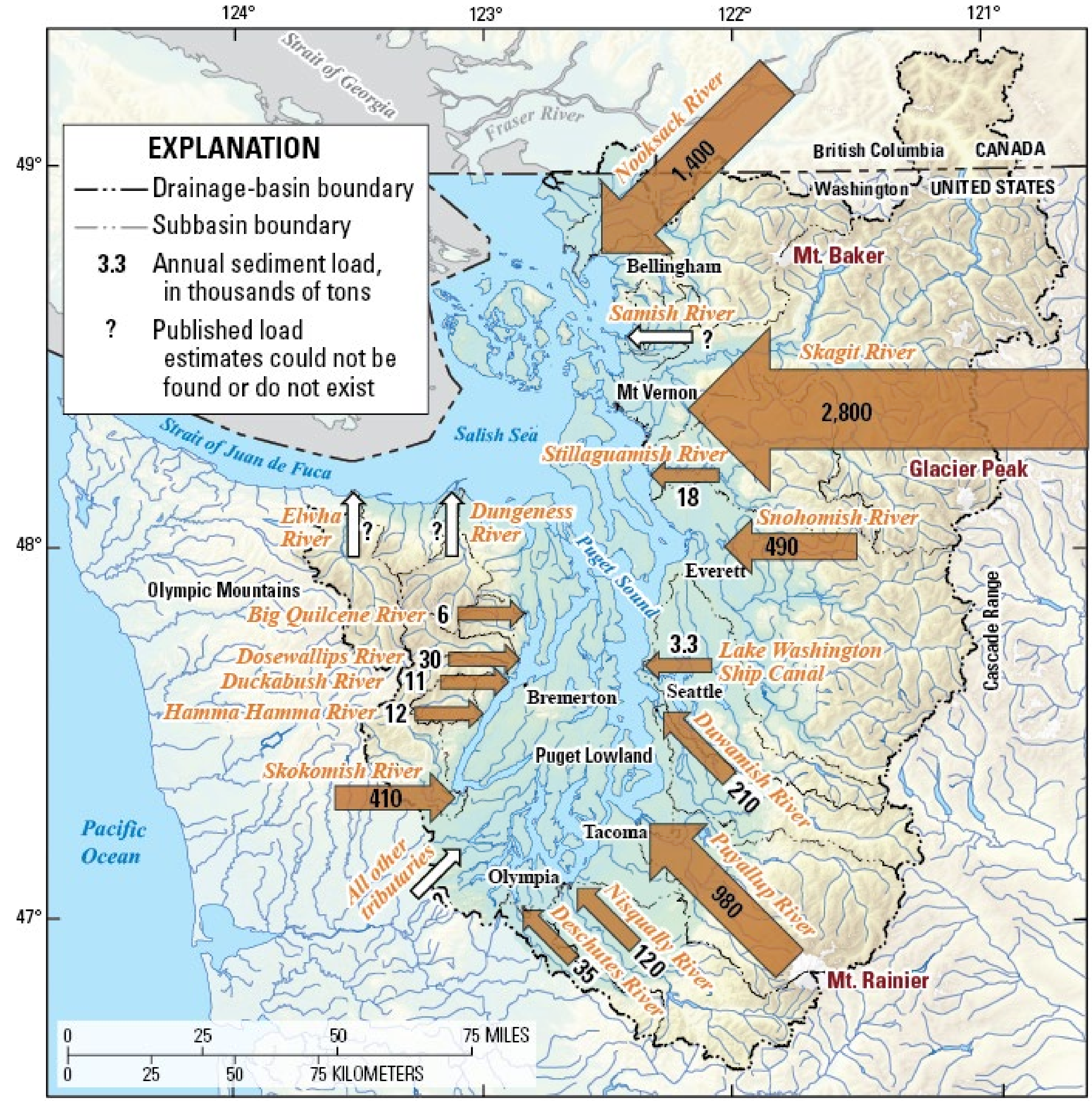


Figure 6. Estuaries and their sediment supply in the Puget Sound. Source: Czubaet al. 2011.

Table 3. Summary of carbon emissions due to historic drainage of wetlands and sequestration with restoration. Source: Crooks et al. 2014.

SCENARIO	ELEVATION (M NAVD88)	AREA (HA)	SOIL CARBON EMISSIONS (T C)	FOREST BIO-MASS CARBON EMISSIONS (T C)	TOTAL EMISSIONS (T C)
HS1: Historic Wetland Drainage	2.6-3.3	4,749	1,707,775	2,811,654	4,519,429
FS1: Planned and Existing Restoration, Restore to Current Tidal Wetland Elevation (2.76m)	0.9-2.76	1,353	-320,570	–	-320,570
FS2: Planned and Existing Restoration, Restore to Future Tidal Wetland Elevation (3.76 m)	2.76-3.76	1,594	-375,319	–	-695,889
FS3: Restore Entire Estuary to Current Tidal Wetland Elevation	0.9-2.76	4,393	-1,224,827	–	-1,224,827
FS4: Restore Entire Estuary to Future Tidal Wetland Elevation (3.76 m)	2.76-3.76	5,258	-1,222,037	–	-2,446,864
Notes: Conservative goal of restoration is to return estuary to emergent tidal wetland elevation. Emergent and scrub-shrub tidal wetland biomass was indeterminate. For these reasons, forest biomass carbon emissions were not calculated for future scenarios. Far right column shows cumulative emissions for different scenarios.					

Note: The historic scenario (hs1) is the only scenario that includes forested tidal wetlands biomass loss, as restoration of wetlands through dike breach for much of the estuary will most likely mainly result in recovery of emergent tidal marshes. Scenarios FS1 and FS2 provide the carbon sequestration that would result from rebuilding of emergent marshes on the planned restoration sites back to existing sea level and with sea level rise of one meter. Scenarios FS3 and FS4 provide the same analysis but hypothetically increasing the extent of restoration to include the whole tidally influenced floodplain area either under existing conditions or with one meter of sea level rise.

It is estimated that historic land use change has resulted in emissions of 4.5 MtC (megatonnes of carbon), of which 2.8 MtC was the result of forested wetland clearance (loss of living biomass) and 1.7 MtC from drained soils. Of the 4,749 ha of converted and drained wetlands, 1,353 ha are currently in planning or construction for restoration. Full estuary restoration of 4,749 ha would rebuild soil carbon stocks of 1.2 MtC as marshes build to emergent wetland tidal elevations and a further 1.2 MtC as they accrete with sea-level rise of 1 meter. Any recovery of forest biomass would be additional to projected soil carbon accumulation.

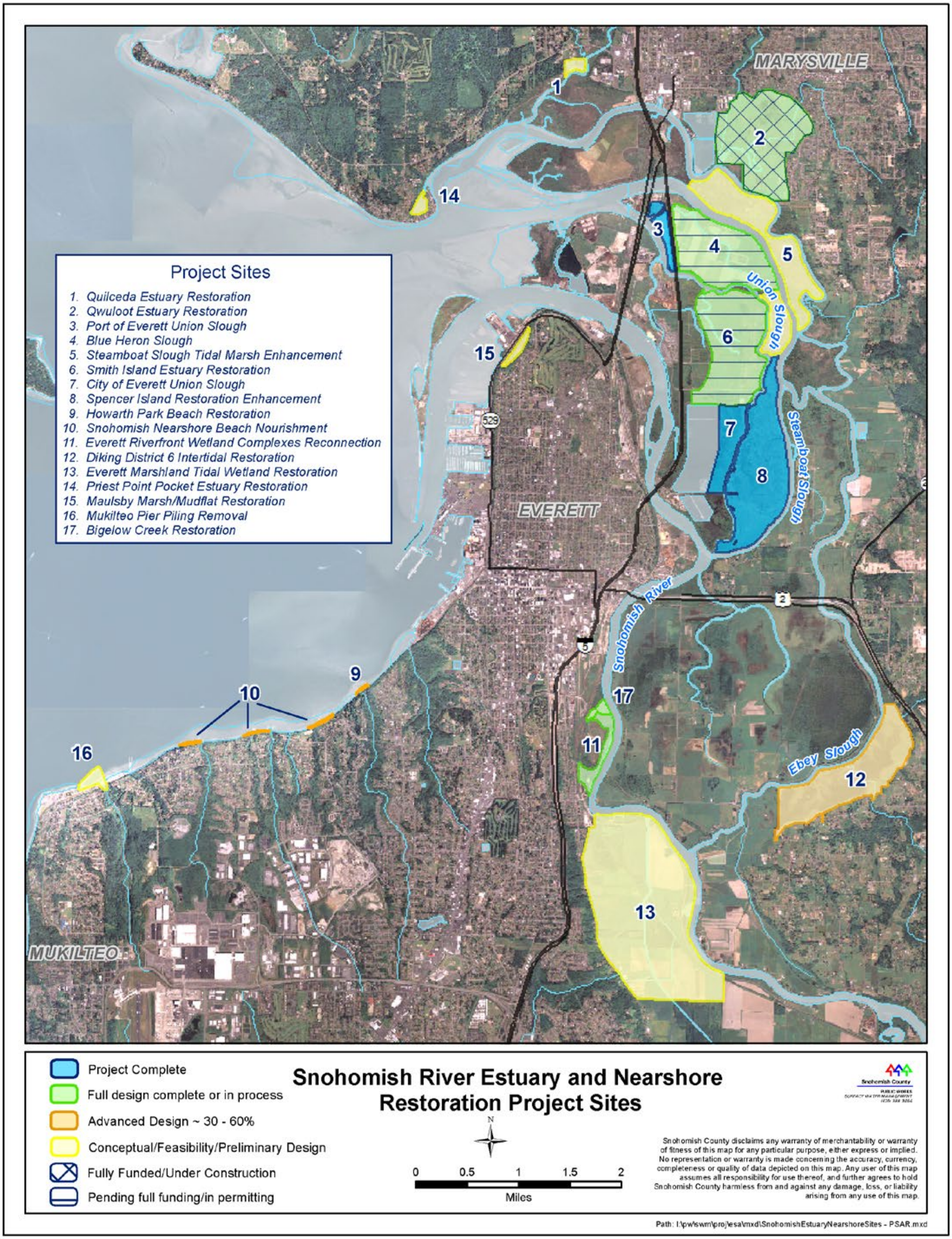


Figure 7. Planned and enacted wetlands restoration projects in the lower Snohomish estuary. Source Crooks et al. 2014.

Not determined in the study were the rates of carbon emissions from drained soils, CH_4 emissions from drainage ditches, nor N_2O emissions from drained soil surface as a result of soil organic decomposition or fertilizer application.

Baseline and with-project scenarios would need to be fully assessed for CH_4 and N_2O emissions/reductions in order to complete consideration for VCS eligibility. However the assessment of planned restoration activities in the Snohomish estuary demonstrates the GHG benefit with regards to CO_2, suggesting a more in depth assessment to pursue carbon credits could be warranted. In addition, other factors would need to be assessed, including additionality, longevity and permanence, leakage, and, where appropriate, sea-level rise.

IV.

First Project Steps: Feasibility Assessment, Site Selection, and Prioritization

Despite the best intentions, not every obstacle can be removed, and not all coastal wetland projects will be able to generate credits for carbon finance. Applying the carbon standard and methodological rulebooks is one thing; securing the success of a project is quite another. It requires careful site selection, robust project design, an early eye to marketing and co-finance options, diligent risk assessment – in a broader sense than the one the VCS applies in its AFOLU Non-Permanence-Tool – and professional and cost-efficient implementation with a commitment to long-term maintenance.

Anyone contemplating the development of a blue carbon project should begin with a **feasibility assessment** that addresses these issues and that delivers a professional expert opinion on whether a carbon finance scenario exists, what the projected returns are, what the roadmap is for key decisions and milestones, and what the relevant risks are. The authors have seen a great many "projects" that have been going on for months and sometimes years, if mostly on paper, with the firm intention to add a "carbon component" to it "in due course", failing to see that a carbon project feasibility assessment early on would have avoided a number of poor design decisions and would have added consistency and robustness to project implementation as a whole.

Much of a carbon feasibility assessment relates to general aspects of the project activities – including technical, social, legal, and financial details – and that 'having the carbon feasibility covered' really means that the project developers have a good understanding of the project risks and opportunities as a whole. Expert counsel may be needed for a number of carbon-specific elements, but it will not replace holistic project planning at the operator level.

In certain cases, itis recommended to cut the feasibility assessment in phases: a pre-feasibility phase and a detailed-assessment phase. When the core parameters of a potential project are not yet identified or when a project faces structural challenges – e.g., it is the first project of this kind in a particular country – then it makes sense to first engage in a pre-feasibility examination, which looks, in an indicative way, at project locations and scenarios, pre-checks available methodologies and the availability of core data needed, and assesses general legal and regulatory issues. The help of outside experts in these areaswill often be useful to gain certainty on questions of eligibility in a short timeframe and without generating high costs. Note that a pre-feasibility assessment may use any available default or educated guess if at that point in time nothing else that meets the standard or methodological requirement is available. At this stage, the methodology may be used for general guidance on GHG accounting.

In the following we will present a number of key aspects that a standard feasibility – and a pre-feasibility – assessment should cover.

1. PROJECT DESIGN AND SITE SELECTION

The feasibility assessment will first look into the available – and most suitable – carbon standards. Guiding questions are, among others, whether:

- The proposed project activity is supported by a standard;
- Methodologies are available or – if not – can be made available;
- The standard and/or methodology and/or proposed project activities have proven viable in past projects;
- The transaction costs involved are not excessive;
- Market premiums are obtainable (e.g., through the use of additional built-on standards such as the CCBA); and
- The project is scalable (to other sites and projects in the future).

In a second step, the feasibility assessment focuses on a number of relevant community and technical characteristics, including:

- An assessment of opportunities and barriers of community engagement;
- An assessment of the available technologies;
- Whether or not to use approved methodologies;
- An assessment of land suitability/eligibility;
- A description of the potential project boundary (follow-up to above: site selection);
- An assessment of the baseline scenario;
- An assessment of the with-project scenario;
- An assessment of leakage;
- An assessment of the additionality;
- An assessment of the non-permanence risk;
- A first description of the project structure; and
- The scope for additional certification schemes (e.g., CCBA, see above).

The output of this part of the feasibility assessment is a summary of the most suitable standard and an overview of social and technical design milestones for implementation.

For site selection, one should define selection criteria based on a clear definition of the goals of the activity. Different sets of criteria may co-exist, which can be structured hierarchically into (first order) "yes/no" and (second order) "more/less" criteria. A project aiming at registration under the VCS must meet essential criteria for the creation of a carbon asset as defined by the VCS project requirements and the eligibility criteria of the GHG accounting methodology. Cost-benefit considerations are usually translated into first order criteria as well. Second order criteria determine if sites are more or less attractive, for example in terms of complexity and optional additional certification of biodiversity and/or social benefits. Depending on the goals defined, the latter may obviously also be first order criteria.

Table 4 gives an example of a VCS/CCBA-eligible WRC project activity with general criteria translated into operational criteria. The items proposed for a feasibility assessment in this and the following section provide a handhold for an effective site selection scheme. The table is not necessarily exhaustive, since feasibility criteria are numerous and their ranking varies across activity types, jurisdictional settings and landscapes.

Table 4. Example of site selection criteria in a WRC project activity applying the VCS methodology for tidal wetland and seagrass restoration (VM0033) and aiming at certifying improved biodiversity and social benefits.

HIERARCHY OF SITE SELECTION CRITERIA	GENERAL CRITERIA (EXAMPLE)	OPERATIONAL CRITERIA (EXAMPLE)
First order	Meet VCS project requirements	· Wetlands drained before January 1, 2008 · Wetland not cleared from native ecosystems within 10 years prior to project start · Project is able to control non-permanence risk factors for at least 30 years (minimum project longevity)
	Meet methodology's eligibility criteria	· Activity is within the scope of the methodology (kind of activity, geographic region) · Land use will not lead to activity shifting in the project scenario · Hydrological connectivity of the project area with adjacent areas will not lead to a significant increase in GHG emissions outside the project area
	Technical feasibility	· Viability of wetlands restoration (e.g., resilience to sea-level rise) is probable · All project activities remain within the scope of the methodology
	Legal and institutional eligibility	· Approval of local authorities is likely · Identification of (a) project proponent(s) successful · Sufficient private title and claim to the project activity and the carbon rights
	Financial feasibility	· Funding source: Carbon (credit amount and timing) · Funding source: Co-funding (advance, interim, long term: donations (including in-kind), equity, loans, other)
	Meet CCBA minimum indicators	· Biodiversity indicators as specified are in place · Social indicators as specified are in place
Second order	Applicability of alternative accounting procedures	· Suitability of various alternative procedures for emissions from soil · Simplified accounting of fire reduction (Fire Reduction Premium) is feasible
	Meet CCBA requirements for Gold Level	· Additional biodiversity indicators as specified · Additional social indicators as specified
	Financial feasibility	· For efficient use of carbon finance · Priority to sites with larger emission reduction potential · Priority to sites with lower implementation cost

2. MARKETING AND CO-FUNDING

The rationale of any carbon project is necessarily twofold: (1) The developer wishes to achieve real, additional, and measurable GHG emission reductions or removals (in support of any other overall purpose, ecologic, social, or other); and (2) the developer wishes to tap into additional funding. How to optimize the carbon finance component should inform the project from the start.

Proceeds from the sale of carbon credits will often make up for a fraction of the total costs only (see box 2), and it falls on the project developer to leverage co-funding. The commoditization of the mitigation benefit (potentially supported by premium standard certification acknowledging the important contributions to water supply, biodiversity, etc.) can be instrumental in tapping into additional sources. In developing countries, these may initially be grants or loans from bilateral or multilateral institutions or other international climate finance tools before other revenues, e.g., from ecosystem services, become available (Crooks et al. 2014); in industrial countries, private or public support and investment linked and underlying the carbon output, or a mix of both, will be crucial.

For *Qwuloolt*, which is part of the Snohomish Estuary, some of the major cost items (up to 2013) have been as follows (as provided by the Tulalip Tribes Natural and Cultural Resources Department, Tulalip, WA; April 30, 2015):

COST ITEM	ESTIMATE OF COSTS (IN MILLION USD)
Property costs	6.0
Levee and breach construction	8.35
Channels, berms, and planting	2.2
Tribal planning/permitting/design	2.0
U.S. Army Corps of Engineers (USACE)	0.65
USACE project management	1.34
TOTAL	**20.54**

The project is funded by a wide group of donors[6] including the Tulalip Tribes of Washington with grant contributions coming from the National Oceanic and Atmospheric Administration's Community-based Restoration Program, the National Oceanic and Atmospheric Administration's Open Rivers Initiative Program, the National Fish and Wildlife Foundation's Puget Sound Marine Conservation Program, the Natural Resource Conservation Service's Wetland Reserve Program, the Pacific Coast Joint Venture, the U.S. Fish and Wildlife Service's National Coastal Wetlands Conservation Program, the Washington Department of Fish and Wildlife's Estuary and Salmon Restoration Program, the Washington State's Aquatic Lands Enhancement Account, the Washington State Recreation and Conservation Office, and the Washington State's Salmon Recovery Funding Board.

[6] *Cf. the project website at http://www.qwuloolt.org/RestorationPlan/ProjectCostSupporters.*

Box 2. Carbon Project Development: Costs and Proceeds

Carbon finance is important, but cannot replace philanthropic and state funding. A project perhaps generates 5 tCO_2eq per acre per year. At a price of 10 USD per tonne, the (gross) carbon revenue is 50 USD per acre per year. For the 400 acres in Qwuloolt, this would mean a revenue of 20,000 USD per year. After 10 years, the revenue would stand at 200,000 USD, after 20 years at 400,000 USD. Assuming that carbon prices may rather go up than down – perhaps to mirror what is understood to be the social costs of carbon[7] to 38 USD in 2015, to 43 USD in 2020, to 48 USD in 2025 and so forth – more funds will come in. However, these numbers pale in comparison to the initial costs for land purchases or leases, construction, and management.

Consider instead that carbon finance, rather than paying for all associated costs of wetland restoration projects, will do the following:

- Cover some of the costs, in particular management/maintenance costs over the first decades;[8]
- Turn donors into investors with a long-term commitment for the future;
- Provide continuous evaluation of the output of a project (measured in tCO_2 and other metrics as per the standards used); and
- Produce exact figures for policy makers on mitigation benefits, abatement costs, and longevity of the project.

Regarding the latter two points, the VCS includes requirements to analyze the effects of sea-level rise on project boundaries and on long-term carbon storage to mitigate the concern of sea-level rise impacts on coastal wetlands restoration or conservation projects in the long term.

From a perspective of landowners (including the government) – who may be willing to cover a big portion of the initial costs (land purchases or leases) – the long-term commitment for maintenance and management will be of particular interest. The channels, dams, and levees built during the construction phase will need to be maintained and repaired over time. Carbon finance, which comes in over time, is a robust incentive for project managers or local communities as a whole, to step in and cover for the works and costs in exchange for a share in the carbon revenues.

From a perspective of government, channeling additional funds into wetland projects that comply with, and are evaluated against, a respectable carbon standard should be more attractive than in independently developed ones. They allow for an accurate measurement of their carbon benefit and other ecological contributions.

Finally, the figures on carbon revenues point to another important aspect: the development of the carbon components – feasibility, preparation of documentation, calculations, validation, verification, carbon asset management – involve costs of their own. These depend on the specifics of the project and the availability of a methodology, but consider, for a typical project (discounting long-term maintenance costs), a cost of between 100,000 and 300,000 USD. A stand-alone project must be big enough to absorb these costs over time. On the other hand, the emergence of "grouped projects" (see chapter 8) is a constructive way to reduce the costs for the integration of new project sites to perhaps around 20,000 USD.

[7] *On social cost of carbon calculation see: http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf; http://www.epa.gov/climatechange/Downloads/EPAactivities/scc-fact-sheet.pdf.*

[8] *Note that the cost ratio may, at times, be a lot more positive. In wetlands projects in Germany developed under the MoorFutures standard, for instance, the restoration prices (including land lease) per acre stood at 50-90 USD. In that instance, the carbon finance component proper makes up for the majority of costs.*

Sound financial planning needs to be a main point of focus for project developers. For the carbon finance part, this means that the developer should build carbon offset commercialization knowledge early in the process and reach out to potential offset buyers (including brokers) and relevant carbon markets. In addition, the project developer should prepare a robust financial feasibility on, among others:

- An assessment of the costs and revenues;
- An assessment of financial flows over the project lifetime;
- A carbon finance-related needs assessment;
- An assessment of best-available practice for the structuring of carbon revenues; and
- An assessment of public or private co-funding sources depending on the application of premium standards, the existence of domestic and (especially important for developing countries) the existence of international climate finance options (such as REDD).

Depending on the outcome of the financial feasibility, the project developer can decide what carbon price is needed, whether advance payments will be necessary, whether to negotiate a carbon transaction 'upstream' (when the project is prepared or in the making), for which a buyer will usually receive a premium, or whether to engage in sales further 'downstream' (when the credits are issued or are about to be issued) at spot sale prices or close to spot prices, respectively.

The output of this part of the feasibility assessment is a financial summary of the key facts of the project in terms of costs, carbon prices, and cash flow scenarios.

3. RISK ASSESSMENT

The feasibility assessment will also include a risk assessment, which builds on the technical and financial characteristics outlined above and which furthermore provides an analysis of the regulatory and legal challenges the project faces – something of particular importance in all land-use based projects.

A blue carbon risk assessment will look at:

- Resilience and reliability of the technology used (e.g., to build dams or ditches);
- The impact of short, mid, or long term sea-level rise and changes to the project demarcation;
- The projected costs of maintenance and technology replacements;
- The handling of unforeseen costs; and
- Carbon market risks (including price volatility, regulatory changes, oversupply, and other).

A legal and institutional blue carbon feasibility assessment will further provide for:

- An assessment of land tenure, carbon rights, and taxation issues;
- An assessment of needs for licenses/permits;
- An assessment of the state of relevant legislation and regulation; and
- An evaluation of the various transactional structures of the project.

The output of this part of the feasibility assessment is a concise risk assessment, ranking risks according to low risk, medium risk, and high risk, and a set of recommendations how any risks identified can be mitigated.

SUMMARY OF FIRST PROJECT STEPS

A feasibility assessment to determine a potential blue carbon project's suitability and anticipated GHG benefit must include, at minimum:

- Social and technical feasibility, including an assessment of opportunities and barriers of community engagement, restoration best practices, anticipated GHG benefits, available methodologies, land suitability, project boundary, additionality, and permanence.
- Financial feasibility, including an estimate of income and expenses, stakeholders, financial flows over lifetime of project, and best practices for structuring carbon finance.
- Legal and institutional feasibility, including carbon and land rights, taxation issues, relevant regulatory requirements, and transactional structures.

Box 3. Snohomish Estuary: Project Preparations and Scope of Feasibility Assessments

Though the Snohomish Estuary study does not represent a full feasibility assessment, it can represent a step in the larger process of project planning. In order to scope out the carbon sequestration benefits for Snohomish Estuary planned restoration projects (similar to the 'with-project' scenario for a blue carbon project), the assessment team looked at available background information on wetland restoration planning. This information included design reports and analysis, modeled hydrology, studies on sediment availability, and documentation of ongoing restoration activities and some associated scientific studies. The blue carbon assessment extended this knowledge by collecting carbon stock and sequestration data from reference natural, restoring, and drained former wetlands and incorporated this information into an geomorphic assessment to quantify the carbon benefits of the planned restoration activities, as well as the maximum potential carbon gain of restoring the whole tidally influenced floodplain under present day sea level and with sea-level rise of 1 meter. This study also provided an opinion on the restoration potential and systems resilience to sea-level rise.

Though the Snohomish Blue Carbon Assessment developed an estimate of the changes in soil carbon stock with ongoing and potential restoration activities, it was beyond the capacity of the study to quantify baseline GHG fluxes. As such, sequestration or emission of carbon on drained lands, CH_4, and N_2O emissions on drained lands and wetlands are yet unknown and would need to be assessed, along with potential emissions from leakage and deductions for non-permanence, for a complete feasibility study.

V.

Using the VCS Methodology for Tidal Wetland and Seagrass Restoration

1. INTRODUCTION

The VCS Methodology for Tidal Wetland and Seagrass Restoration (VM0033; referred to herein as the "Methodology") is an important addition to the land-use sector of the carbon markets. This Methodology provides eligibility criteria and transparent and conservative procedures to estimate net greenhouse gas (GHG) emission reductions and removals resulting from the restoration and creation of tidal wetlands and seagrasses.

In addition to the VCS restoration methodology, Restore America's Estuaries, Silvestrum, and the other authors of the restoration methodology have begun work on a methodology for the greenhouse gas benefits of coastal wetland conservation. Most of the carbon in blue carbon ecosystems is in soils – preventing the degradation of these ecosystems can prevent a significant CO_2 emission; the conservation methodology will enable wetland conservation projects to capture the avoided emissions as a carbon credit.

In this chapter, we provide guidance on the following sections of the VCS restoration methodology:

- Applicability Conditions;
- Project Boundary;
- Additionality;
- Quantification of GHG emission reductions and removals; and
- Monitoring.

2. APPLICABILITY CONDITIONS

The applicability conditions chapter provides information about which projects are allowable in the Methodology. This includes general rules on what types of projects are eligible, conditions designed to exclude leakage, and situations for which the Methodology does not provide procedures.

Eligible projects:

The Methodology adopts a broad definition of restoration and a variety of restoration activities may be eligible, including wetland creation projects. The definition covers any projects that create, restore, or manage hydrological conditions; alter sediment supply; change salinity characteristics; improve water quality; (re-)introduce native plant communities; and/or improve management practices. Example restoration activities include:

- Creating, restoring and/or managing hydrological conditions (e.g. removing tidal barriers, improving hydrological connectivity, restoring tidal flow to wetlands or lowering water levels on impounded wetlands);
- Altering sediment supply (e.g. beneficial use of dredge material or diverting river sediments to sediment-starved areas);
- Changing salinity characteristics (e.g. restoring tidal flow to tidally-restricted areas);
- Improving water quality (e.g. reducing nutrient loads leading to improved water clarity to expand seagrass meadows, recovering tidal and other hydrologic flushing and exchange, or reducing nutrient residence time);
- (Re-)introducing native plant communities (e.g. reseeding or replanting); and
- Improving management practice(s) (e.g. removing invasive species, reduced grazing).

Box 4. Potential Project Activities in the Snohomish Estuary

The existing landscape of the Snohomish consists of a mix of agricultural lands and grasslands under varying degrees of management, including those with water tables at depth and at the surface. Common practice for wetlands restoration involves removal of barriers and restoring tidal flows and sediment supply to recover wetlands.

Looking at the landscape scale, across the estuary a mosaic of potential project activities may be developed and connected under the restoration methodology. These include: 1) rewetting of drained lands (if it can be demonstrated that carbon dioxide emissions are currently occurring); 2) restoration of river floodplains; 3) afforestation of diked lands or restored floodplains; 4) restoration of emergent tidal marsh; and 5) lowering of water table on impounded lands. Together a whole suite of restoration activities can be enacted that result in near term emissions reductions but also build resilience in project outcome when connected across the landscape.

Applicability conditions related to leakage:

There are several applicability conditions related to leakage, which refers to when a project causes additional greenhouse gas emissions in areas outside of the project area. Under the Methodology, projects that cause leakage are not allowed.(See chapter 5.5 for a more extensive discussion of leakage.) Applicability conditions related to leakage include: restrictions on current and past land use; and hydrologic connectivity with adjacent areas.

Additional applicability conditions:

The following applicability conditions are included because the Methodology does not provide procedures for the estimation of emissions associated with these activities:

- The burning of organic soil as a project activity is not allowed; and
- Nitrogen fertilizer(s) may not be applied.

For projects that want to claim emission reductions from peat fires, the Methodology requires that project activities include (1) a combination of rewetting and fire management;(2) demonstration that a threat of frequent on-site fires exists; and (3) demonstration that the fires have an anthropogenic origin. Only under these conditions can the *Fire Reduction Premium* approach be applied. See chapter 5.5i for further guidance on this procedure.

The Methodology includes the following applicability conditions to meet specific VCS requirements for wetlands projects:

- Project activities may lower the water table only where the project converts open water to tidal wetlands, or where lowering the water table maintains wetland conditions as a component of a restoration project. This is to meet the requirement that project activities that actively lower the water table depth in wetlands are not eligible.

- In peatland strata, afforestation, reforestation, and revegetation (ARR) activities must be combined with rewetting, to meet the requirement that ARR activities on peatland shall not enhance peat oxidation.

3. PROJECT BOUNDARY

The project boundary consists of the temporal boundary, the geographic boundary, and boundaries related to the relevant carbon pools and GHGs. In this section we provide guidance on temporal and geographic boundaries, as they may involve challenges specific to coastal wetland restoration. We also cover wetland restoration-related boundary issues related to carbon pools and GHGs.

a. Temporal Boundaries:

The subject of temporal boundaries in WRC project activities pertains to the crediting period, the longevity of the project, the permanence issue, and the peat or soil organic matter depletion time (PDT or SDT). The VCS sets a minimum of 20 years for the crediting period, but the non-permanence risk rules in the VCS Standard (see the Non-permanence Risk Tool and chapter4) require the longevity of a project to be at least 30 years. Because this period is also realistically the maximum timeframe for carbon transactions, the crediting period is usually set at 30 years. A project sets a crediting time once and it remains fixed. After the crediting period the contractual obligations of the project proponent with respect to the issuance of carbon credits expire, unless the crediting period is renewed. Renewal may occur up to four times but the total crediting period may not exceed 100 years. GHG accounting for the remaining period until the 100-year time mark is governed by the non-permanence risk assessment, i.e., a higher risk of non-permanence after the crediting period yields a higher buffer withholding, and vice versa (see section on risk assessment in chapter 4.3).

In addition to using the Non-permanence Risk Tool, non-permanence[9] also has a direct quantitative aspect. For projects quantifying CO_2 emission reductions (i.e.,avoided losses), areas within the project boundary which do not achieve a significant difference (≥ 5%) in cumulative carbon loss over a period of 100 years beyond the project start date are not eligible for carbon crediting based on the reduction of baseline emissions.These areas must be mapped as well.

The maximum eligible GHG emission reductions from soils is limited to:

1. The difference between the remaining soil organic carbon stock in the with-project and baseline scenarios after 100 years (total stock approach), or
2. The difference in cumulative soil organic carbon loss in both scenarios over a period of 100 years since the project start date (stock loss approach).

The assessment must be executed *ex ante* using conservative parameters.

[9] *See UNEP & CIFOR 2014 for a discussion of the relevance of non-permanence risk assessments for WRC emissions avoidance projects.*

Box 5. Understanding "Conservative" Values

Under "conservativeness", the VCS understands the use of robust and resistant assumptions, values and procedures to ensure that net GHG emission reductions or removals are not overestimated (VCS Standard). For example, baseline emissions may not be overestimated and baseline carbon sequestration may not be underestimated. The reverse is true for the project scenario.

Local peer-reviewed or IPCC default values may be used without any restrictions, as they are considered appropriate in all cases.

The soil organic matter depletion time (SDT) is one of the aspects of temporal project boundaries specific to wetlands. The SDT must be estimated for projects that claim the reduction of baseline GHG emissions through the prevention of soil organic matter oxidation in **mineral soils** ("avoided losses"). SDT is the time it would have taken for the soil organic carbon to be lost due to oxidation or to reach a steady stock where no further losses occur. No GHG emissions reductions may be claimed for a given area of wetland for longer than the SDT. The procedure for determining the SDT shall conservatively consider soil organic carbon content and oxidation rate within the project boundary and may be estimated based on the relationship between water table depth and soil organic carbon content in the project area. Where wetland soils are subject to sedimentation or erosion, the procedure for determining the SDT must conservatively account for the associated gain or loss of soil organic carbon. In case of alternating mineral and organic horizons, the rate of organic soil carbon loss may be determined for all individual horizons. This also applies to cases where an organic surface layer of less than 10 cm exists or in cases where the soil is classified as organic but its organic matter depletion is expected within the project crediting period and oxidation of organic matter in an underlying mineral soil may occur within this period.The project proponent has, therefore, the option to use the rate of organic soil carbon loss $Rate_{Closs\text{-}BSL,i}$ (measured in t C ha^{-1} yr^{-1}) instead of the rate of organic soil loss $Rate_{peatloss\text{-}BSL,i}$ (see below, measured in m yr^{-1}) for organic layers.

This assessment is not mandatory in cases where soil organic carbon content on average may be deemed *de minimis*.

Associated with SDT is peat depletion time (PDT), which must be estimated for projects that claim the reduction of baseline GHG emissions through the prevention of soil organic matter oxidation in **organic soils** ("avoided losses"). PDT is the time it would have taken for the peat to be completely lost due to oxidation or other losses, or for the peat depth to reach a level where no further oxidation or other losses occur. No GHG emission reductions may be claimed for a given area of peatland for longer than the PDT. The procedure for determining the PDT must conservatively consider peat depth and oxidation rate within the project boundary and may be estimated based on the relationship between water table depth, subsidence (e.g., using peat loss and water table depth relationships established in scientific literature), and peat depth in the project area. If the PDT falls within the crediting period, subsequent organic carbon loss from remaining mineral soil may be estimated as well using the procedure for SDT as outlined above.

Box 6. Soil Organic Matter Depletion in the Snohomish Estuary

Baseline soil carbon emissions on drained lands in the Snohomish have not been measured. However, the methodology does not allow projects to claim emission reductions for strata that have already been drained for more than twenty years (i.e., the soil organic carbon depletion time in the baseline is then set to zero). Since drainage occurred about 90 years ago and because of the mineral nature of the soils, accounting for any reduction of baseline emissions is not eligible. This is not always the case on coastal soils. For systems with more organic soils, emissions may continue for decades, depending upon land management practices and soil conditions, such as is observed and quantified in the Sacramento-San Joaquin Delta where diked and drained organic soils now lie 20 feet below sea level (Deveral and Leighton 2010).

b. Geographic Boundaries

Project proponents must define the project boundary at the beginning of a proposed project activity and must provide the geographical coordinates of lands (including sub tidal seagrass areas, where relevant) to be included. In the determination of geographical project boundaries, for both the baseline and project scenarios, 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, for which the Methodology provides guidance. It would be conservatively appropriate to consider the high rate of sea-level rise provided by the IPCC or similar scientific authorities.

An essential aspect of defining the project boundary is that the project proponent, at validation, can demonstrate control over it, evidenced by a right of use. A **right of use** is 'the unconditional, undisputed, and unencumbered ability to claim that the relevant project will or did generate or cause a GHG emission reduction or removal' (VCS Standard). Right of use can take various forms in different jurisdictions. (See chapter 7 for further guidance on legal and institutional matters.) Grouped projects are allowed to expand their project area after validation, provided that the geographic boundary in which grouped project instances may occur and criteria for their inclusion in the grouped project are set out at validation. (See chapter 8 for further guidance on grouped projects.)

Box 7. Snohomish Project Boundary

Within the Snohomish, as other coastal systems, there is opportunity to either initiate individual projects or group projects together under a larger regional or "jurisdictional" project. Typical forestry carbon projects are 10,000 ha or greater in size, as a result of project costs and economies of scale. Coastal wetland restoration projects are commonly much smaller than this, with four of the largest projects in the Snohomish enacted to date totaling 1,353 ha in area.

To account for the impacts of sea-level rise and the uncertainty in the impacts on GHG management the regional project boundary should be set to include the lower river floodplain (including drained lands on it) as well as the area of emergent and former emergent tidal marshes. In this particular part of Puget Sound we are not considering seagrasses, but they could be considered in other settings.

c. Stratification

Stratification may be used to subdivide the project into spatially explicit strata that are sufficiently homogenous, simplifying project accounting procedures which can then be applied identically for each stratum. These areas do not have to be adjacent; a single stratum can cover many spatially separated polygons within a project area (including separation across large distances in grouped projects).

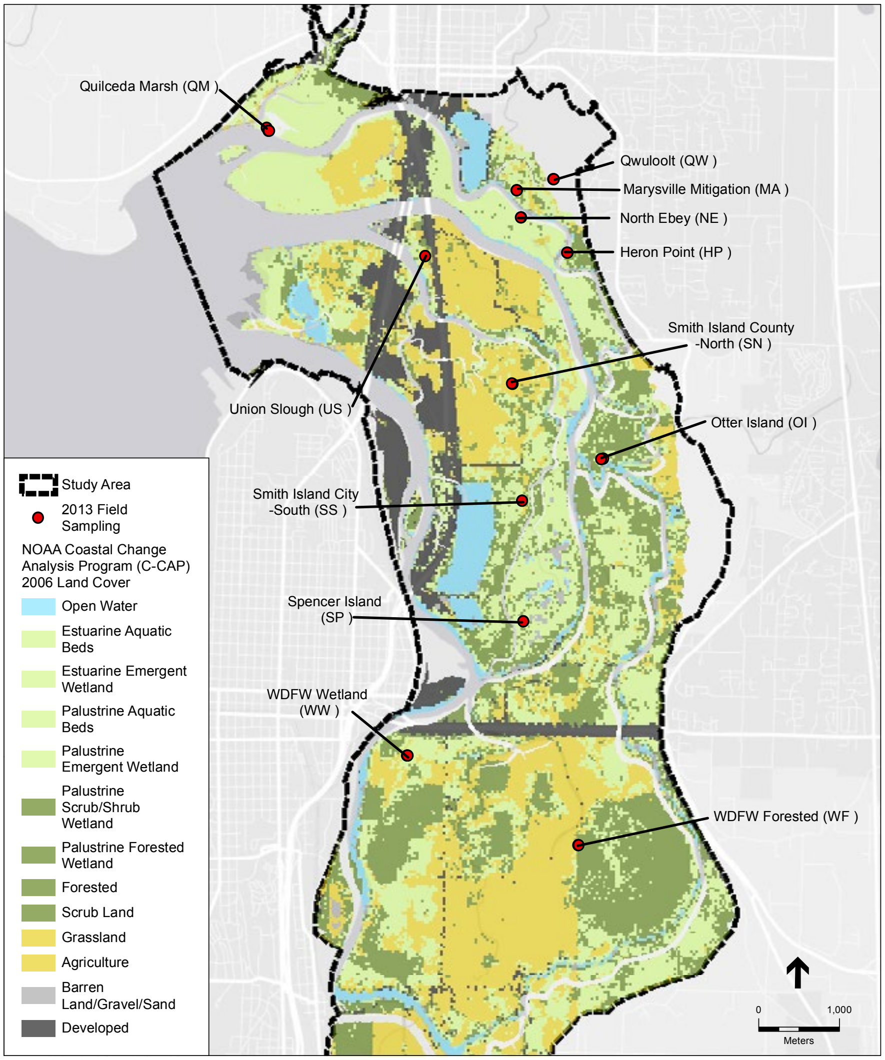
Strata may be chosen to encompass areas with similar:

- Soil type and depth;
- Water table depth;
- Vegetation cover and/or composition;
- Salinity;
- Land type; or
- Expected changes in these characteristics over the life of the project.

Increasing the number of strata will improve the accuracy and precision of estimates by decreasing sample error, thereby lowering the number of samples that need to be collected. The Methodology provides guidance about when to use different stratifications under various baseline and project scenarios.

Box 8. Stratification in the Snohomish Estuary

Challenges in stratification of the baseline scenario include: the complexity of existing uses, their water table management or condition (if unmanaged), and the nature of GHG fluxes. This is illustrated in figure 8 which illustrates the range of existing land management practices in the Snohomish estuary. The project proponent must decide on whether to account for these emissions or whether to conservatively assume that emissions are zero in the baseline (i.e., not recognize this potential gain to reduce project costs).



SOURCE: NOAA CCAP, 2006; WWU, 2013
Service Layer Credits: Copyright: ©2013 Esri, DeLorme, NAVTEQ

Snohomish Estuary Blue Carbon Assessment . P12073

Figure 6
Snohomish Estuary Land Cover - 2006
Snohomish County, Washington

Figure 8. Land uses in the Snohomish estuary (Source data NOAA CCAP 2006, collated in Crooks et al. 2014).

d. Boundaries Related to Carbon Pools and GHG Emissions

Depending on project conditions, soil organic carbon, biomass, and wood products are the only carbon pools included in the Methodology. Litter and dead wood pools are not included (the VCS standard refers to these as optional pools in WRC projects) (see table 5.1 in Methodology).

Relevant GHGs for WRC project activities are CO_2, CH_4, and N_2O. CO_2 is usually the dominant GHG, but CH_4 may come into play as a dominant gas under certain conditions. CO_2 emissions must be estimated in the baseline scenario and in the with-project scenario. CH_4 and N_2O emissions in the baseline scenario may be conservatively set to zero. CH_4 must be estimated in the with-project scenario. N_2O emissions must be accounted for in the project scenario in strata where water level was lowered as a result of project activities. Seagrass projects do not require N_2O emission accounting. Projects may use various approaches for the quantification of these three GHGs, as outlined in chapter 5.5.

4. ADDITIONALITY

As previously discussed, a project developer needs to show that the project would not happen without 'additional' finance from carbon offset generation. This can be accomplished using the CDM Additionality Tool,[10] or through an alternate approach. The VCS established new standardized methods to demonstrate additionality, including what they refer to as 'performance methods' and 'activity methods'.

The restoration methodology applies an **activity method** to pre-determine additionality. In general, 'activity methods' are for activities that:

- Are not financially viable without carbon finance,
- Have no revenue streams other than carbon finance, or
- Have low rates of adoption in the marketplace.

The purpose of the activity method is to streamline additionality where carbon finance can be a catalyst for new projects.

For the Methodology, RAE examined data for tidal wetland restoration in the U.S. to determine a level of restoration. Broadly put, the question we sought to answer was "how much restoration has occurred compared to how much could occur?" We calculated the level of restoration to be 2.71% – well under the threshold of 5% in the VCS standard. For this reason, **all new tidal wetland restoration in the U.S. that is not otherwise required by law or regulation is additional.** The rationale for this is that the opportunity and need for restoration in the U.S. is so much greater than the nation's ability to fund it, and it is occurring at very low levels compared to restoration goals, that the addition of carbon finance to the funding mix can catalyze new restoration and improve the quantity and quality of restoration.

The Methodology applies this standardized approach only to tidal wetland and seagrass projects occurring in the U.S., i.e., such projects are all deemed additional. Projects outside of the U.S., must follow the project method by applying the CDM tool. This tool provides comprehensive procedures for the determination of the most likely baseline scenario and the assessment of additionality.

5. QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

a. Overview of the Three Greenhouse Gases: CO_2, CH_4, N_2O

A blue carbon project must account for the baseline and with-project emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) – the three prevalent gases affected by natural processes. Emissions may be negative (signifying removal of a gas from the atmosphere) or positive (signifying the release of a gas to the atmosphere). A project needs to have net negative emissions (i.e., a positive emission reduction) in order to claim blue carbon credits. This is achieved by having lower total emissions in the project scenario compared to the baseline scenario.

There are two major means through which a project can generate negative CO_2 emissions: (1) avoiding the release of CO_2 in the baseline scenario by decreasing the oxidation of soil organic carbon ("avoided losses" or "stop-loss"); or (2) increasing the uptake of CO_2 in the with-project scenario by increasing carbon sequestration in soils and plants. Projects may accomplish both, and as such the benefits are additive.

[10] *Combined tool to identify the baseline scenario and demonstrate additionality for A/R CDM project activities.*

Carbon dioxide emissions are generally not measured directly in blue carbon projects due to the high variability and cost of such measurements. Rather, the net stock change of carbon is estimated or another proxy is used.

For the **stock change approach** the net change in the amount of organic carbon in the plants and soils in the project area are estimated, and then converted to units of CO_2. In forestry, carbon stock changes in biomass and soil are normally used as a proxy for CO_2 emissions or removals.

A **proxy** involves the use of a measured variable to infer the value of a variable of interest (emissions). Under the VCS, proxies may be specified where it can be demonstrated that they are strongly correlated with the variable of interest. For example, water table depth may substitute for CO_2 emissions from peatland. In addition to emissions related to vegetation and soil changes, CO_2 emissions from fuel usage must in certain cases be accounted, e.g., where machinery use for earth moving activities is significant in wetland restoration.

Methane (CH_4) is a greenhouse gas that is sometimes generated through the decomposition of soil organic matter and biomass under saturated (oxygen-free) conditions. CH_4 is a more potent greenhouse gas than CO_2; the VCS provides a conversion factor to convert CH_4 into CO_2–equivalent units (CO_2eq). In some cases, CH_4 emissions will remain the same or be increased through blue carbon projects. There are also cases where CH_4 emissions will be reduced through a project, such as through increased salinity, in which cases the project can generate credits. If the project increases CH_4 emissions, these CO_2eq units will need to be deducted from the project's overall emission benefits.

Nitrous oxide (N_2O) is a particularly potent greenhouse gas that can be generated when nitrate (NO_3^-; a common form of nitrogen) is present during the decomposition of soil organic matter and biomass under moderate levels of oxygen. If there is a lot of oxygen available, then microbes don't need to convert NO_3^- to N_2O. If there is very little oxygen available, microbes will convert NO_3^- all the way to nitrogen gas (N_2), thereby not generating N_2O. For these reasons, **the VCS methodology only requires projects to account for a possible increase in N_2O emissions with projects that decrease water levels** (if the project does not change or increase water levels, it is safe to assume that N_2O emissions are not being increased). Examples of project activities that would decrease water levels, and therefore need to account for N_2O emissions, are impoundment breaching and dredged material placement. If a project developer believes that they may be lowering N_2O emissions, then they are able to account for this and receive the credits.

Box 9. GHG Emissions in the Snohomish Estuary

A challenge facing project development involving coastal wetlands is the complexity of land uses in the baseline, their water table management or condition (if unmanaged) and the nature of GHG fluxes. The project proponent must decide whether to account for these emissions or whether to conservatively assume that emissions are zero in the baseline (i.e., not recognize this potential gain to reduce project costs). In a low salinity system such as the Snohomish, increased methane emissions may result through wetland restoration and must be accounted for. N_2O emissions will likely be reduced with projects in the Snohomish, as creating permanently wet soil conditions will reduce emissions relative to the baseline.

While technologies exist to determine GHG fluxes through direct measurement, the step has not been taken to calibrate models or develop default values for emissions based upon land uses and water management. For a pre-feasibility assessment some tier-one default values are provided by the IPCC. Given the landscape and climate specific nature of wetland GHG emissions it wouldbe beneficial to develop Puget Sound and estuary scale emissions factors for baseline conditions and with-project activities.

b. Accounting for Sea-Level Rise

Accounting for sea-level rise in the Methodology requires the determination of the fate of biomass and soil carbon stocks upon submergence and erosion.

Where biomass is submerged, it is assumed that this carbon is immediately and entirely returned to the atmosphere, but restoration projects involving afforestation or reforestation may account for long-term carbon storage in wood products in cases where trees are harvested before dieback.

In the baseline scenario, it is conservatively assumed that, upon submergence, soil carbon is not returned to the atmosphere. The onus is upon the project proponent to provide site-specific scientific justification for CO_2 emissions of eroded soil organic carbon. Reversely, for the project scenario, the project proponent may conservatively assume that all eroded carbon is oxidized, or may justify a smaller oxidation rate based on appropriate scientific research. Submerged non-eroded soil carbon is assumed to be preserved in the with-project scenario (not returned to the atmosphere).

Appendix 1 provides example outcomes in hypothetical cases of mangrove and floodplain restoration based on assumptions on biomass growth, carbon stored in wood products, and oxidation constants.

Box 10. Snohomish Example: Sea-Level Rise Issues

The Snohomish estuary is an example of a system with high potential resilience to sea-level rise in that the elevation is suitable for vegetated wetlands to recover should tidal waters be restored on drained lands.Organic and mineral sedimentation builds restoring marshes at rates higher than present rates of sea-level rise, and the topography is appropriate to incorporate river floodplains (possibly reforested) within the project as an accommodation area for sea-level rise migration(Crooks et al. 2014b).

A carbon project could be developed for Snohomish based upon the emergent wetland area only. If the project were to also include restoration of the lower river floodplain and potentially reforestation of that floodplain, this would bring enhanced ecosystem benefits along with project resilience to sea-level rise. By creating additional space should sea-level rise occur rapidly, reforested areas would be replaced by emergent marsh; and if sea-level rises slowly, then forested wetlands and emergent wetlands will have been restored. Building such flexible approaches into project planning will reduce project risk of failure.

Examples of project resilient to sea-level rise include wetlands in areas with low mineral sediment supply input (so reducing capacity of the wetland to build in place with sea-level rise) as long as they have a space upland to migrate and/or will transition to seagrass areas that anchor sequestered soil carbon.

Not all coastal wetlands will be resilient to sea-level rise and this should be considered in project evaluation.

c. General Information on Accounting Methods

Project proponents have several options to account for greenhouse gas emissions. A project is always allowed to assume that an emission is zero when that would be a conservative assumption (i.e., assuming zero gives the least possible carbon credit)—this reduces the need to spend time and funds accounting for something that is likely to be of minimal benefit. Significant negative baseline emissions (removals) and significant positive emissions in the project scenario must always be accounted for. If a project wants or needs to account for a greenhouse gas emission, they generally have the following options:

- Default values and emission factors;
- Published values;
- Modeling;
- Proxies; and
- Field-collected data.

Default Values and Emission Factors

Default values and emission factors are provided in the Methodology wherever such scientifically credible values are available. The Methodology also allows for projects to use externally published default values and emission factors in certain cases (when they are derived from peer-reviewed literature and are appropriate to the ecosystem type, conditions, and geographic region of the project area). The IPCC has published many emission factors. The coarsest level of emission factor that the IPCC publishes is called "Tier 1". These values may be used by project proponents for the VCS methodology in certain cases, but project proponents must justify their use as appropriate for project conditions.

Table 5. Tiers that may be used to assess emission factors. Source: Howard et al. 2014 with additions by the authors.

TIER	REQUIREMENTS	COMMENTS
1	IPCC default factors	Tier 1 assessments have the least accuracy and certainty and are based on simplified assumptions and published IPCC default values for activity data and emissions factors. Tier 1 assessments may have a large error range, for example +/- 50% for aboveground pools and +/- 90% for the variable soil carbon pools.
2	Country-specific data for key factors	Tier 2 assessments include some country or site-specific data and hence have increased accuracy and resolution. For example, a country may know the mean carbon stock or emission for different ecosystem types within the country.
3	Detailed inventory of key carbon stocks and emission rates, repeated measurements of key stocks and emission rates through time or modeling	Tier 3 assessments require highly specific data of the carbon stocks and emission rates in each component ecosystem or land use area, and repeated measurements of key carbon stocks and emission rates through time to provide estimates of change or flux of carbon into or out of the area. Estimates of carbon flux can be provided through direct field measurements or by modeling.

The use of default values and emission factors are generally the easiest option for project proponents. Guidelines are given for when these values may be applied. They may not be applied when there are published values available for a given wetland system. This is to prevent situations where published data show that the emissions rate for a system should give less carbon credits than would be given through the default value or emission factor.

Published Values

Published values may be used to generate values for the average rate of the emissions of a given greenhouse gas provided the values are derived from data published in a peer-reviewed venue. The data must be from “the same or similar systems” as those in the project area. This means that the project proponents must make the case to the validator that the data came from the project area itself or from an area sufficiently similar in terms of geomorphic, hydrologic, and biological properties, and management regimes such that any differences should not have a substantial effect on GHG emissions.

Models

Models are another option for estimating greenhouse gas emissions. The Methodology sets a fairly high standard for the use of models (see table 6); many current models are not yet adequately developed and tested. To be used, a model must be validated with direct measurements from a system with the same or similar water table depth and dynamics, salinity, tidal hydrology, sediment supply, and plant community type as the project system. This is a significant area for research and growth in the blue carbon world—the advancement and testing of models over the coming decades holds tremendous promise to increase the feasibility of many blue carbon projects.

Table 6. VCS methodology requirements for the use of models. Source: VCS Version 3 Requirements Document, 8 October 2013, v3.4.

VCS METHODOLOGY REQUIREMENTS – USE OF MODELS
Where methodologies allow the use of specific models to simulate processes that generate GHG emissions, the following applies:
1. Models shall be publicly available, though not necessarily free of charge, from a reputable and recognized source (e.g., IPCC, government agency, etc.).
2. Model parameters should be determined based upon studies by appropriately qualified experts that identify the parameters as important drivers of the model output variable(s).
3. Models should be reviewed and tested (e.g., ground-truthed using empirical data) by an appropriate organization, or a peer review group.
4. All plausible sources of model uncertainty, such as structural or parameter uncertainty, shall be assessed using recognized statistical approaches such as those described in the 2006 IPCC Guidelines.
5. Models should have requirements for estimating uncertainty in keeping with IPCC or other relevant guidance, and should be calibrated by parameters such as geographic location and local climate data.
6. Models should apply conservative factors to discount model uncertainty and use conservative assumptions that are likely to underestimate, rather than overestimate, the GHG emission reductions or removals.
Note: The criteria in #2-6 are targeted at more complex models. For simpler models, some criteria may be disregarded if not appropriate or necessary.

Proxies

Project proponents may also use proxies to estimate greenhouse gas emissions. A proxy is any environmental variable that is highly correlated to a greenhouse gas emission rate; to be useful a proxy is relatively easy to measure (in particular, it's easier to measure than the greenhouse gas emission rate itself). An example of the use of proxies comes from the peatland world, where methane emissions can be estimated from plant community composition. Proxies are not well developed for tidal wetlands, but the Methodology allows project proponents to justify the use of any proxy to the validator.

Field-Collected Data

Lastly, project proponents can directly measure greenhouse gas emission rates or carbon stock changes through field sampling. This will often be the most expensive and cumbersome option, but it will be necessary in some cases. For carbon dioxide, sampling usually means measuring the change in the amount (stock) of soil and/or plant carbon in the system. For methane and nitrous oxide, sampling means directly measuring gas fluxes. The details of these measurements are discussed below.

Box 11. Defining and Differentiating Processes in Organic and Mineral Soils

In several parts of the Methodology, project proponents need to determine whether their tidal wetlands have organic or mineral soils. These definitions refer to what is present at the surface of the soils of a wetland because the surface of a wetland soil represents "current" soil formation processes. For example, if a restoration was done to substantially increase sedimentation rates in a formerly sediment-starved system, the surface of the soil would soon contain mineral soil materials while the deeper layers would contain organic soil materials.

An organic soil is defined as "a soil with a surface layer of material that has a sufficient depth and percentage of organic carbon to meet thresholds set by the IPCC (Wetlands supplement) for an organic soil." Because of the IPCC definition, if an organic layer of less than 10 cm has accumulated, the soil is by definition considered mineral.

Organic soil definition in the IPCC wetlands supplement:

In line with the 2006 IPCC Guidelines (Annex 3A.5, Chapter 3, Volume 4), a soil that satisfies the following two requirements:

1) Thickness of organic horizon greater than or equal to 10 cm. A horizon of less than 20 cm must have 12 percent or more organic carbon when mixed to a depth of 20 cm;

2) Have either: a) At least 12 percent organic carbon by weight (i.e., about 20 percent organic matter) if the soil has no clay; or b) At least 18 percent organic carbon by weight (i.e., about 30 percent organic matter) if the soil has 60% or more clay; or c) An intermediate proportional amount of organic carbon for intermediate amounts of clay.

Except for the 10 cm criterion mentioned under 1) the 2006 IPCC Guidelines do not define a minimum thickness for the organic horizon to allow for country-specific definitions of organic soil.

Note that the above definition excludes live roots, but the Methodology only requires the removal of live coarse below-ground tree biomass due to the difficulty in removing finer roots. Also note that in certain parameters in the Methodology 'peat' is used interchangeably with the term 'organic soil'.

d. Soil CO_2 Oxidation in the Baseline Scenario

In many cases, a significant part of the benefit of a blue carbon project may be avoided losses—the prevention of the oxidation (decomposition) of soil organic matter in the baseline scenario (e.g., through re-wetting a drained tidal peatland or shrimp farm). This is also sometimes called "stop-loss". The Methodology divides such projects into those with organic versus those with mineral soils. **Projects with organic soils** have the greatest potential to benefit from stop-loss due to the large carbon stocks present in these systems. When the organic matter is exposed to oxygen it decomposes in organic soils causing the soil volume to decrease dramatically—for this reason the Methodology allows projects to measure the historical rate of decrease in soil depth as a means to predict what the future loss of soil depth (soil volume) would have been in the absence of the project (until all the peat would have been lost). **Mineral soils** have lower but still significant potential to lose carbon in a drained condition. However, the loss of carbon in mineral soils is not as directly tied to a loss in soil volume; therefore, projects cannot use the loss of soil depth as a measure of this loss. Rather, projects may estimate the rate of organic soil carbon loss due to oxidation in the baseline scenario using either historical data collected from the project site or chronosequence data collected at similar sites. In mineral soils, the rate of soil organic matter oxidation tends to be most rapid immediately following the drainage of a wetland and eventually becomes very slow; therefore projects are required to account for this general pattern in their estimates. Also, the methodology does not allow projects to get credit for strata that have already been drained for more than 20 years or that are experiencing erosion.

e. Soil CO_2 Sequestration in the With-Project Scenario

For most projects that are restoring tidal marsh and mangrove systems, the simplest option to estimate soil CO_2 sequestration will be to use the default value provided in the Methodology of **1.46 t C ha^{-1}yr^{-1}**. Projects with mineral soils will need to calculate a deduction for allochthonous carbon from this default value—see below for more on this. The default value may not be used if published data are available (see above) or if the vegetation crown cover is less than 50%. If the crown cover is lower than 50% in the with-project scenario, then it is likely that the wetland is not sequestering high amounts of carbon. This may occur in the early years of a project before the vegetation is well established or if a wetland is not healthy, for example if it is beginning to break up and submerge due to sea-level rise.

As described above, models and proxies are not yet sufficiently developed and tested for use in blue carbon projects, which leaves field data collection as the primary additional option available to projects (in addition to published data and the default value). There is no default value available for seagrass projects, so field-collected data will be needed for such projects unless published data are available.

See chapter 6 for details about monitoring and sample size requirements for use of the field-collected data method.

f. Autochthonous Versus Allochthonous Carbon

Blue carbon is divided into two types: autochthonous and allochthonous. **Autochthonous carbon** is carbon that is removed from the atmosphere (through photosynthesis) within the project area at the soil surface. **Allochthonous carbon** is removed from the atmosphere outside the project area and then moved into and deposited into the projected area at the soil surface. All autochthonous carbon is considered to be credit-worthy for a project. Allochthonous carbon is only considered to be worthy of credits for a project if it can be demonstrated that it would have been returned to the atmosphere in the absence in the project. This can be difficult to demonstrate, but the Methodology does allow project proponents to make their case to a validator if they choose to do so. Otherwise, the Methodology provides the following methods to deduct for allochthonous carbon. This calculation may be done for either total or recalcitrant allochthonous carbon (see box 12).

There are two situations where a project may assume that allochthonous carbon is zero—for organic soils and seagrass systems using a specific sampling method. It is assumed that allochthonous carbon is very low in organic soils because such soils receive little surface deposition of mineral-associated carbon. In seagrass systems, the deduction of the sampling method "layer with soil organic carbon indistinguishable from the baseline SOC concentration" (see below) functions to subtract out allochthonous carbon. For this reason, seagrasses may claim a deduction of zero if they are using this method such that the allochthonous carbon is not deducted twice (see chapter 5.5f).

Projects with mineral soils need to estimate a deduction for allochthonous carbon (unless they would like to make the case to their validator that they shouldn't, as mentioned above). The Methodology provides multiple options for advanced users, but the best and easiest option for estimating this deduction will generally be to collect cores of surface soils in the field. Surface soils are used because allochthonous carbon is deposited at the surface. These samples may be analyzed for either carbon or organic matter. Multiple samples must be collected (see chapter 6 to estimate minimum sample size), but samples may be composited by strata to minimize laboratory analysis costs. The Methodology then provides equations to estimate the deduction for allochthonous carbon from this value (see figure 9).

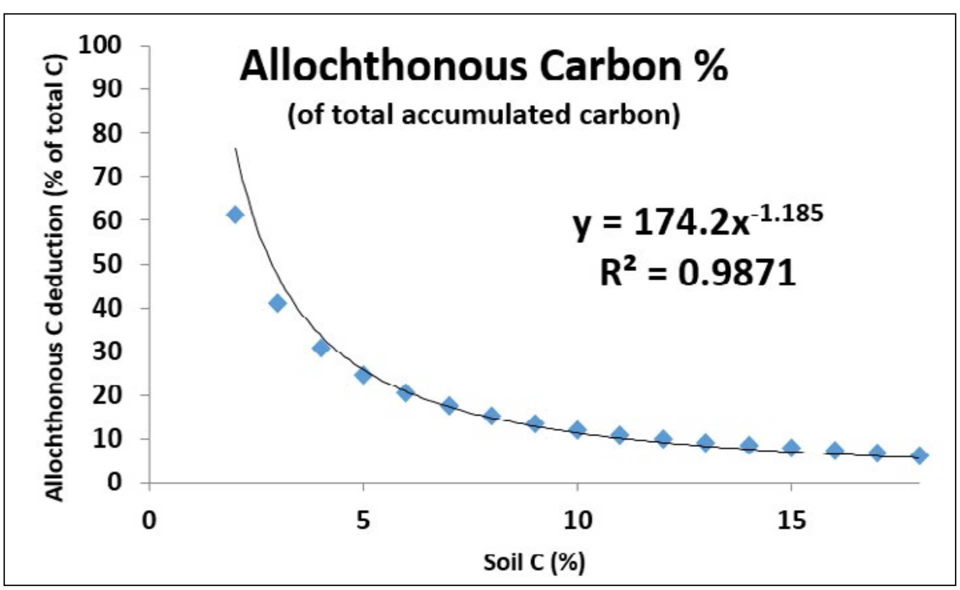


Figure 9. Generalized estimate of the carbon credit deduction to account for allochthonous carbon for a mangrove project with surface mineral soils. Note that the deduction is fairly small except with soils with low soil carbon contents; which are projects that are generally not be the best candidates for blue carbon projects anyway. Source: Methodology for Tidal Wetland and Seagrass Restoration.

Box 12. "Recalcitrant" Allochthonous Carbon

The Methodology allows for the calculation of either total or "recalcitrant" allochthonous carbon. "Recalcitrant" carbon is the fraction of the organic carbon that is highly resistant to being decomposed, often because it is closely associated with mineral particles and/or is in a complex molecular form due to a past history of decomposition. Most of the non-recalcitrant allochthonous carbon that is deposited in a project area will be decomposed and returned to the atmosphere, which is why the Methodology allows projects to only take a deduction based on the recalcitrant allochthonous fraction. In fact, much of what the Methodology defines as recalcitrant carbon will likely never return to the atmosphere in the absence of the project, but it is nonetheless conservative to deduct it. Project proponents have the option to lower or eliminate this deduction if they can justify this to the validator.

g. Methane Accounting

Project proponents have a similar set of options for accounting for methane emissions as they do for carbon dioxide emissions. Published values are an excellent option if such data exist (or even if such data can be collected and published). Otherwise the default value option will likely be the easiest option. However, **default values are only provided for tidal wetlands with a salinity low point or average greater than 18 ppt** (Poffenbarger et al. 2011). Salinity is a proxy for the availability of sulfate, which suppresses the microbial production of methane. This is one of the most significant limitations in the application of this Methodology—if you are working with a lower salinity wetland and there are no available published data for your system, then you will need to use one of the accounting methods described below, all of which are significantly more difficult to apply than the default value method.

There are two default values provided in the Methodology for methane emissions, one for salinity low point or average > 18 ppt and one for salinity low point or average > 20 ppt. Both of these values are relatively low and will represent a fairly small deduction from the overall carbon credits earned by the project (Poffenbarger et al. 2011). Salinity may be measured using a handheld salinity refractometer or other accepted technology. Salinity may be measured on shallow soil-pore water (within 30 cm from soil surface) or from the floodwater source (such as an adjacent tidal creek) as long as there is regular hydrologic exchange between the source and the wetland (defined as at least 20% flooding of high tides). The **salinity low point** is the lowest value collected during the period of peak methane emissions (e.g., during the growing season in temperate ecosystems or the wet season in tropical ecosystems). The salinity average is calculated from measurements taken at least monthly for one year.

In lower salinity marshes, additional accounting options are models, proxies, and field-collected data. Models have not been developed yet that meet the requirements for use in the Methodology. Once such models are developed, they will need to be validated with direct measurements from a system with the same or similar water table depth and dynamics, salinity, tidal hydrology, sediment supply, and plant community type as the project system. Similarly, proxies have yet to be developed to estimate methane emissions from tidal wetland systems. The development and validation of models and proxies to estimate methane emissions from fresh and brackish tidal wetlands is among the greatest challenges facing the research community over the coming decades to facilitate the adoption of blue carbon crediting. Until these models and proxies are developed, project developers may use published or field-collected data for projects in these systems.

The remaining option for project proponents is field-collection of methane emissions data. These emissions data may be collected using closed chamber techniques or chamber-less techniques such as eddy covariance flux. The field-collected data option will work best for tidal wetlands with low methane emissions, which would be relatively easy to document. It will be more difficult for projects with more moderate methane emission rates because it will be very expensive to conduct the sampling. Sites with high emission rates in the with-project scenario are probably not good candidates for blue carbon projects regardless.

The number of samples required is primarily determined by the coefficient of variation of the data (see chapter 5.6g)—methane emissions can have a coefficient of variation of about 1.0, which would mean more than 40 samples per stratum (for the chamber sampling method) (Megonigal 1996; Megonigal and Schlesinger 2002). Given the need for repeated measurements over time and the expense and equipment costs associated with each sampling, this will only be economically feasible for projects with large strata (including either single or grouped projects). Eddy covariance techniques are also costly, which will also likely limit them to large projects.

h. Nitrous Oxide Accounting

As described above, nitrous oxide emissions should only increase in the with-project scenario in cases where the water table is lowered—so other projects (including seagrasses) do not need to account for nitrous oxide emissions. If you do have a project where the water table is lowered, then you may also avoid the need to account for nitrous oxide emissions by demonstrating to the validator that N_2O emissions do not increase in the project scenario compared to the baseline scenario or that this increase is insignificant (e.g., by referring to peer-reviewed literature based on similar project circumstances). Otherwise, you must use one of the accounting methods.

The Methodology provides labor and cost-efficient means for N_2O accounting. Once again, the easiest option is default values, which may only be used when there are no published values available and when the project area does not receive hydrologically direct inputs from a point or non-point source of nitrogen such as wastewater effluent or an intensively nitrogen-fertilized system. Note that these nitrogen inputs must be direct, so default values may be used even if your project area lies in a generally eutrophic system. The default values vary by salinity and open water versus vegetated systems. Values for most non-tidal wetland systems may be taken from published IPCC reports, which will be useful for many baseline scenarios. The Methodology allows the flexibility to use proxy-based, field-collected, and modeled data, but these methods are only required in cases where the default value is not allowed and published data are not available.

Nitrogen fertilizers (including manure) may not be applied in the project area, which avoids the direct increase of nitrous oxide emissions that may be caused by such applications.

i. Natural and Prescribed Fire Emission reductions due to rewetting and fire management (*Fire Reduction Premium*)

The *Fire Reduction Premium* approach addresses human-induced peat fires occurring in drained peatland and establishes a conservative default factor, based on fire occurrence in the baseline scenario. In the case of catastrophic fires in the project scenario, the procedure holds and the fire reduction premium may still be claimed. However, in the case of failure of rewetting and fire management, the premium is cancelled. The VCS defines 'catastrophic (reversal)' as: "A type of reversal caused by disasters such as hurricanes, earthquakes, flooding, drought, fires, tornados, or winter storms, or man-made events over which the project proponent has no control such as acts of terrorism or war".

This procedure concerns a rapid and conservative alternative approach to acknowledge peat fire emission reductions as a result of rewetting without having to develop complex baseline scenarios for peat fires. The procedure refers to the VCS module "VMD0046 Methods for monitoring of soil carbon stock changes and greenhouse gas emissions and removals in peatland rewetting and conservation project activities". The module provides the rationale of the procedure and outlines the procedure to quantify the term *FRP* (or Fire Reduction Premium). For each peat stratum to which the project proponent applies the approach, the parameters $E_{peatsoil\text{-}WPS,i,t}$ (Greenhouse gas emissions from the peat soil within the project boundary in the project scenario in stratum i in year t (t CO_2eq yr^{-1})) and $E_{peatsoil\text{-}BSL,i,,t}$ (GHG emissions from microbial decomposition of the peat soil within the project boundary in the baseline scenario in stratum i in year t (t CO_2eq yr^{-1})) in the module are obtained from $GHG_{WPS\text{-}soil,i,t}$ and $GHG_{BSL\text{-}soil,i,t}$. The application of the procedure is conditional: all of the four criteria must be met.

Prescribed fire

Prescribed fire is an important tidal wetland management technique used in parts of the world to improve marsh habitat, avoid the risk of natural fire, and improve the production of some wetland plant species. In some cases this improved plant production may offset the direct losses of carbon during burning through increased above and belowground plant production, leading to increased soil carbon accumulation and overall net carbon accumulation. For these reasons, the Methodology allows for prescribed fire in the with-project scenario, but only under certain conditions:

- The burning of peat is not allowed;
- The burning of trees is not allowed (herbaceous and shrub vegetation may be burned); and
- The project must demonstrate that burning is not decreasing carbon sequestration rates if they are using the 'general default factor approach' for carbon

dioxide emissions accounting from soil (see section 8.1.4.2.3 “Default factors” in the Methodology).

In addition to carbon dioxide, prescribed fire also releases methane and nitrous oxide. Accounting of these emissions is done by estimating herbaceous and shrub biomass using a default factor or field-collected data; this biomass value is then multiplied by emission factors provided in the Methodology to estimate methane and nitrous oxide.

j. Leakage

For wetlands projects, the VCS distinguished three types of leakage:

1. **Market leakage** occurs when projects significantly reduce the production of a commodity causing a change in the supply and market demand equilibrium that results in a shift of production elsewhere to make up for the lost supply.

2. **Activity-shifting leakage** occurs when the actual agent of deforestation and/or forest or wetland degradation moves to an area outside of the project boundary and continues its deforestation or degradation activities elsewhere.

3. **Ecological leakage** occurs in WRC projects where a project activity causes changes in GHG emissions or fluxes of GHG emissions from ecosystems that are hydrologically connected to the project area.

The quantification of these types of leakage can be challenging; if they occur they have the potential of undermining the entire carbon asset of a project. Therefore, the Methodology, through its applicability conditions, requires pre-project conditions and project implementation to be such that they prevent leakage effects.

For wetland carbon projects, one concern is that conserving or restoring habitat values in one location will displace economic activity (such as fish farming) to another area of wetlands either nearby or elsewhere. The displaced economic activity could cause GHG emissions or reduce carbon sequestration; this is referred to as either activity-shifting leakage or market leakage. To prevent this, the Methodology, for example, requires that projects be implemented on areas that have been free of any land use that could be displaced outside the project area for at least two years.

To prevent ecological leakage, the Methodology prohibits projects where hydrological connectivity of the project area with adjacent areas leads to a significant increase in GHG emissions outside the project area. For example, when the project raises the water table, this may affect the water table outside the project boundary, causing dieback of vegetation and subsequent CO_2 emissions. The Methodology provides procedures for demonstrating that this applicability condition is met including Table 8.1, which describes processes associated with ecological leakage and criteria that may be used to demonstrate that this leakage is avoided.

SUMMARY OF CARBON ACCOUNTING CONCEPTS

Must account for three primary GHGs (CO_2, CH_4, and N_2O). For credits, the project must result in lower net emissions in the with-project scenario compared to the baseline scenario.
General Options for GHG Accounting include:

- Default values and emission factors;
- Published values;
- Modeling;
- Proxies; and
- Field-collected data.

CO_2 Accounting:
Determine whether organic and/or mineral soils are present.

- Organic soils have the greatest potential to benefit from avoided losses due to the large carbon stocks present in these systems.
- Mineral soils have lower but still significant potential for avoided losses.
- For most projects that restore either a mangrove or a tidal marsh system, the simplest option is to use the default carbon sequestration rate provided in the Methodology of **1.46 t C $ha^{-1}yr^{-1}$.**

Allochthonous vs. Autochthonous Accounting:

- Projects with mineral soils must calculate a deduction for allochthonous carbon from the default values and field-collected soil carbon or organic matter data (default values may not be used if published data are available) by:
  1. Collecting cores of surface soils in the field; and
  2. Using equations provided by the Methodology to estimate the deduction for allochthonous carbon from either carbon or organic matter values.
- Allochthonous carbon may be assumed to be zero for:
  - Organic soils, and
  - Seagrass projects using the sampling method of "layer with soil organic carbon indistinguishable from the baseline SOC concentration"

CH_4 Accounting:

- Published values, if such data exist.
- Default values (likely be the easiest option) – provided for tidal wetlands with a salinity low point or average greater than 18 ppt.
- In lower salinity marshes, accounting options are models and proxies (not yet developed), and field-collected data (using closed chamber techniques or chamber-less techniques such as eddy covariance flux).

N_2O Accounting:

- Nitrous oxide emission should only increase in cases where the water table is lowered – other projects (including seagrasses) do not need to account for nitrous oxide emissions.
- If the water table is lowered, then you may avoid the need to account for nitrous oxide emissions by demonstrating to the validator that N_2O emissions do not increase in the project scenario compared to the baseline scenario or that this increase is insignificant.
- Or use one of the following accounting methods:
    - Default values, which may only be used when there are no published values available and when the project area does not receive hydrologically direct inputs from a point or non-point source of nitrogen.
    - Proxy-based, field-collected, and modelled data; these methods should only be needed in unusual cases (such as high direct nitrogen inputs).

k. Calculation of Verified Carbon Units (Calculating Buffer Withholding)

A risk assessment is an integral part of the validation procedure under the VCS and much general information is required to assess and quantify the risk. Under the VCS wetland restoration methodology, project proponents are instructed to use the VCS Non-Permanence Risk Tool (http://www.v-c-s.org/program-documents), which provides a comprehensive procedure for assessing risk of reversal of carbon stocks. Risk of reversal (e.g., unintended loss of biomass due to fire or illegal harvesting) is a specific kind of risk strictly associated with carbon projects involving carbon sinks (such as peat) and is thus relevant for all AFOLU projects. Project activities generating emissions reductions of N_2O, CH_4, or fossil fuel-derived CO_2 are not subject to the withholding of credits in a buffer, since these GHG benefits cannot be reversed. The risk rating is used to determine the number of buffer credits that an AFOLU project shall deposit into the VCS AFOLU pooled buffer account.This pooled buffer account holds non-tradable buffer credits to cover the non-permanence risk associated with AFOLU projects. It is a single account that holds the buffer credits for all projects.

While the VCS risk tool is a valuable tool for assessing important risk factors (and addressing non-permanence for the purpose of project registration), by its limited scope it does not cover all risk factors relevant for a carbon project nor does it at all times generate a risk score that can be considered accurate investment risk advice. An example is political risk, where the maximum score in this tool is 6%, while obviously in politically very unstable or dynamic situations a score of up to 60% or more (i.e., total failure) would be warranted. Therefore, the risk rating must not replace an investment risk assessment.

In AFOLU projects, the buffer usually applied may be up to 30% of the emission reductions estimated using the Methodology and therefore this part of the accounting will be quite essential for investors. During the crediting period and upon verification of the project, buffer credits may be recovered by the project proponent based on an outcome of the risk assessment that is more favorable than the previous one. However, after the crediting period all buffer credits will expire.

Internal Risk

Risks can be mitigated by a strong project design and qualified management. Project management with significant experience in AFOLU and wetland restoration project design and implementation, carbon accounting and reporting may even mitigate some risk factors, yielding a negative score.

In the VCS risk tool, the financial viability of a project is based on 1) the number of years until cash flow breakeven is reached, and 2) the funding that has already been secured relative to what is needed to implement and operate the project until reaching the cash flow breakeven. In the unfavourable and unlikely case that project cash flow breakeven point is greater than 10 years from the current risk assessment, and the project has secured less than 15% of funding needed to cover the total cash out before the project reaches breakeven, the total score for financial viability is 6%. It is usually relatively easy to improve on these parameters but this part of the assessment deserves attention at an early stage of project development.

According to the tool, an opportunity cost analysis is required based on the alternative land uses identified in the project's additionality assessment, except where the majority of baseline activities over the length of the project crediting period are subsistence-driven. Note that if the project is eligible to use the standardized approach (see Additionality), no alternative baseline scenarios are identified and we assume that the assessment can be based on the current baseline scenario.

The opportunity cost analysis involves a Net Present Value(NPV) analysis. Such an analysis is not required in case of subsistence-driven land use, but instead an assessment of the net impacts of the project on the social and economic wellbeing of the communities who derive livelihoods from the project area is required. In case the NPV of the most profitable alternative land use activity is expected to exceed with-project activities by more than 100%, the risk score is 8%. The same score is given when, in case of subsistence-driven baseline activities, net positive community impacts are not demonstrated. This is a quite significant score and a project is therefore likely to be motivated to perform better in terms of NPV overall, or when displacing or affecting subsistence-driven activities. In the case of displacing or affecting subsistence-driven activities, the project should aim at a net positive community impact, which will also allow a positive score under the Climate Community and Biodiversity Alliance (CCBA). In the event of a risk score above zero, the fact that the project is protected by a legally binding commitment to continue management practices that protect the credited carbon stocks over the length of the project crediting period will mitigate the score by 2%.

Project longevity means the number of years that project activities will be maintained. If evidence can be provided that right of use can be maintained for the entire project longevity period, the project performs well against this risk factor, particular if there is legal agreement or requirement to continue the management practice and assuming a project longevity of 30 years. According to the tool, the score will then be 15%. Please note that the timeframe for permanence under the VCS is 100 years, i.e., projects with a longevity of 100 years or more are deemed to be 'permanent'; therefore, the shorter the project longevity, the higher the risk rating.

External Risk

If in more than 5% of the project area there exist disputes over land tenure or ownership, the risk rating for land tenure will be 10%. However, if through project preparation it can be shown that continued management practices are legally protected so that carbon stocks over the length of the project crediting period are protected, there is a mitigation score of 2%. Where disputes over land tenure, ownership or access/use rights exist and documented evidence is provided that activities have been undertaken to resolve the disputes or clarify overlapping claims, there is an additional discount in risk. Hence, while there seems to be scope for limiting the risk score for land tenure to a few percentage points in developing countries, in Western societies such as the U.S. the score is likely to be zero. The risk assessment is done *ex ante* and *ex post*, in some cases likely with a different result if the problem existed at validation and was solved at verification.

For WRC projects there is a specific provision for projects unable to demonstrate that potential upstream and sea impacts that could undermine issued credits in the next 10 years are irrelevant or expected to be insignificant, or that there is a plan in place for effectively mitigating such impacts. Such projects must apply a risk score of 5%.

A geomorphic and hydrologic assessment can inform the project on the likely risks of upstream or downstream impacts. In the U.S., most wetlands restoration projects require documentation and mitigation of impacts to other wetlands and so measures are already in place to assess such impacts.

If households living within the project area who are reliant on the project area will be consulted, and those living within 20 km of the project boundary outside the project area, and who are reliant on the project area will also be consulted, as is the case in properly designed and socially sustainable projects, the score on the external factor will be minimal. Arguably, if the project generates net positive impacts on the social and economic well-being of the local communities who derive livelihoods from the project area, either by their displacement or by improving their livelihoods, a mitigation score of -5% is within reach.

Political risk is assessed on the basis of governance score to be calculated from the mean of Governance Scores across the six indicators of the World Bank Institute's Worldwide Governance Indicators (WGI). In the worst case the hit will be 6% for some countries, however, if REDD+ readiness activities are implemented, the score will be mitigated by -2%. For the U.S. and other Western countries the score will be low.

Natural Risk

Natural risk is based on the likelihood and significance of fire, disease, extreme weather, and other such events. Mitigation of risk can occur through mitigation and prevention measures. Sea-level rise is not seen as a natural risk but rather a process that needs to be accounted for in the baseline and the project scenarios, for which the Methodology provides procedures. However, WRC projects must assess phenomena such as changes in the seasonal timing and depth of the water table and, where applicable, wrack deposition in tidal wetlands, associated with natural risks such as storms and droughts. Good project design will incorporate resilience to natural events that will happen. Natural risks are also part of the baseline and should be part of the project planning. Natural systems are dynamic and a good project should include resilience to natural events.

6. MONITORING

For a good introduction to the relevance of monitoring of project implementation and emissions or emission-related proxies, we refer readers to Olander &Ebeling 2011. In the following we will focus on aspects of monitoring relevant to tidal wetlands.

1. Sample Size Requirements

To estimate sample size, the Methodology has project proponents use a tool published by the UNFCCC entitled "Calculation of the number of sample plots for measurements within A/R CDM project activities". This CDM tool determines sample size requirements as a function of the coefficient of variation of the quantity being estimated (i.e., emissions) (figure 10). The coefficient of variation is the mean divided by the standard error. The project proponent must have an estimate of the coefficient of variation prior to the sampling. If you have such an estimate available, it is advisable to add some additional samples to increase the likelihood of having the sufficient number (see below).

If you do not have an estimate, you can use an estimate from the literature. The largest coefficient of variation present in the studies reviewed by Chmura et al. 2003 for carbon sequestration rates in tidal marshes and mangroves was 0.7, and most were below 0.5. Values in this range require sample sizes of approximately 10–20 samples per stratum. As mentioned above, coefficients of variation for methane fluxes are closer to 1.0, requiring about 40 samples per stratum, which will be cost-prohibitive for many projects. Note that samples may be composited for some measurements (such as for the estimate of soil carbon needed for allochthonous carbon estimation).

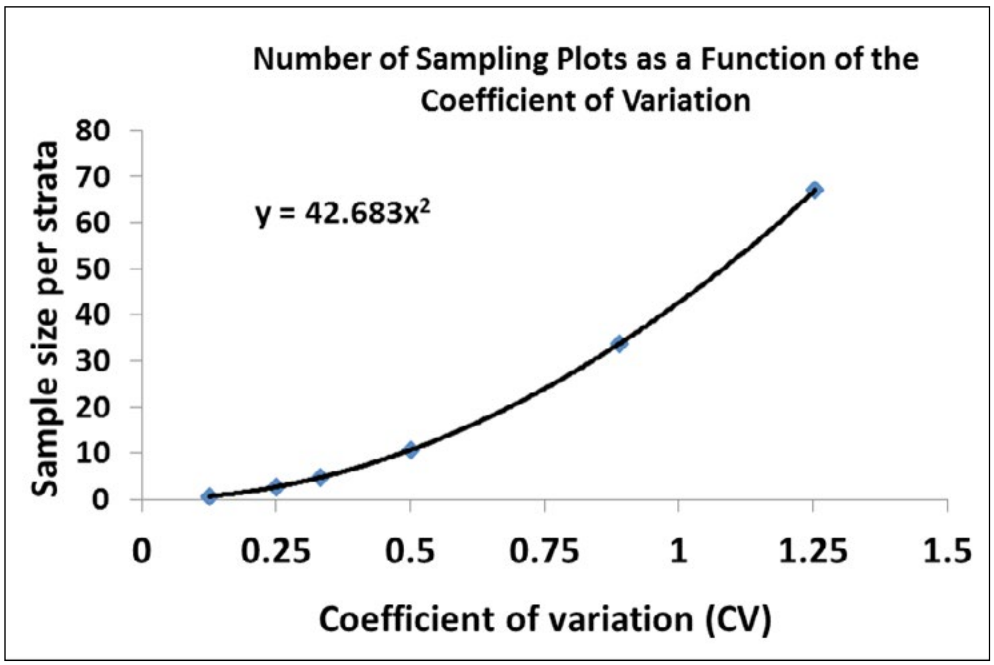


Figure 10. Sample size requirements as a function of the coefficient of variation of the quantity being estimated (i.e., emissions) calculated using the CDM tool "Calculation of the number of sample plots for measurements within A/R CDM project activities". Source: Methodology for Tidal Wetland and Seagrass Restoration.

The project proponent may choose in the restoration methodology whether to use a 90% targeted confidence interval with a 20% error allowance or a 95% targeted confidence interval with a 30% error allowance. It turns out that the 95% targeted confidence interval requires fewer samples due to the greater error allowance, so most project proponents will likely choose this option. If you perform the sampling and it turns out that you did not have enough samples, in other words you had more variability in your data than was expected in your data, then you will need to take a deduction (a "confidence deduction") from your carbon credits—this is described in Section 8.4.2 of the Methodology. A confidence deduction is not attractive as it likely adds heavily to the non-permanence withholding already suffered (see chapters 3 and 4 on non-permanence risk assessment), thereby negatively affecting the carbon asset and the return on investment. For this reason, it is good project planning to have a high number of samples.

2. Field Collection of Soil Cores

For projects that are required or choose to collect field data to estimate soil carbon sequestration, cores must be collected to estimate the rate of organic carbon accumulation above a consistent reference plane. The Methodology allows a wide variety of options for establishing such a reference plane, and even includes the phrase "other accepted technologies" such that new techniques can be used as they are developed. The list given in the Methodology is: a marker horizon (most commonly using feldspar), a strongly contrasting soil layer (such as the boundary between organic and mineral soil materials), an installed reference plane (such as the shallow marker in a surface elevation table), a layer identified biogeochemically (such as through radionuclides, heavy metal, or biological tracers), or a layer with soil organic carbon indistinguishable from the baseline SOC concentration.

The method "layer with soil organic carbon indistinguishable from the baseline SOC concentration" is particularly meant for use in seagrass projects (Greiner et al. 2013). The idea in these projects is that you sample deep enough such that you get below the depth that is being influenced by the seagrasses themselves, and this underlying layer is representative of the carbon that would be deposited in the aquatic system through other processes (including allochthonous carbon). By subtracting out the carbon content of this underlying layer from the overlying layer, you are able to estimate the amount of autochthonous carbon resulting solely from the influence of the seagrasses.

Soil samples collected above this reference plane (however it is established), must be analyzed for both bulk density and either carbon or organic matter (through loss-on-ignition). The Methodology provides equations to convert organic matter analyses to estimates of carbon concentrations. Inorganic carbon must be removed prior to analysis. The Methodology requires removal of coarse live belowground tree biomass (removal of fine biomass from peat samples is not required due to the difficulty in such removal).

3. Methane and Nitrous Oxide Emission Monitoring

If needed or desired, project proponents have two methodological options to monitor methane and/or nitrous oxide emissions: closed chambers or chamber-less techniques such as eddy covariance flux. Both of these methods require advanced expertise and specialized equipment. Closed chambers involve the installation of a semi-permanent frame in the wetland surface and then the periodic installation of a chamber on top of that frame, which is then monitored for the accumulation of gases (generally for one hour). Eddy covariance methods monitor the fluxes of gases being emitted from a wetland from a platform above the wetland, and therefore must account for atmospheric conditions such as wind to estimate air movement patterns. Monitoring methane emissions from areas lacking vegetation (<25% cover), such as open water, hollows or ponds, is further complicated because methane from these areas is frequently emitted in the form of bubbles (called ebullition).

The accounting for methane and nitrous oxide emissions may be done either as "accurate" or "conservative". An "accurate" monitoring program collects enough data such that an accurate estimate of the mean emissions can be determined – this will likely result in a lower value but will require more monitoring. A "conservative" monitoring program only needs to collect measurements at the times and places in which methane or nitrous oxide emissions are expected to be the highest, allowing for a smaller monitoring program but resulting in a larger estimate.

SUMMARY OF MONITORING CONCEPTS

Sample size requirements:

- To estimate sample size, the Methodology refers to a tool that determines sample size requirements as a function of the coefficient of variation of the quantity being estimated.
- Coefficients of variation for methane fluxes have been found to be about 1.0, requiring about 40 sampling locations per strata, which would be cost-prohibitive for many projects.
- Samples may be composited for some measurements (such as for the estimate of soil carbon needed for allochthonous carbon estimation), which makes the acquisition of large sample sizes relatively easy.
- Most projects should use a 95% targeted confidence with a 30% error allowance, which requires fewer samples due to the greater error allowance.
- If you perform the sampling and it turns out that you didn't have enough samples, then you will need to take a deduction (a "confidence deduction") from your carbon credits.

Field Collection of Soil Data:

- Collect cores to estimate the rate of organic carbon accumulation above a consistent reference plane.
- Soil samples collected above this reference plane must be analyzed for both bulk density and either carbon or organic matter.

CH_4 and N_2O Monitoring:

Two methodological options to monitor methane and/or nitrous oxide emissions: closed chambers or chamber-less techniques such as eddy covariance flux. Both of these methods require advanced expertise and specialized equipment.

VI.

Registration, Institutions, and Stakeholders

The carbon credit cycle consists of a number of mandatory procedural steps, representations and authorizations. While some of these may look burdensome, they have contributed significantly to building a standard that is widely accepted by practitioners, civil society, and the market as transparent and environmentally robust.

For any VCS project, the project developer or project owner assumes the role as '*project proponent*', which the VCS defines as the "individual or organization that has overall control and responsibility for the project, or an individual or organization that together with others, each of which is also a project proponent, has overall control or responsibility for the project".

The project proponent does not need to be the landowner or hold a land lease. It needs to show, however, that it is the entity that validly assumes the "right of use" of the land to implement the project and generate GHG emission reduction or removals. The VCS does not come with a legal analysis of the conditions under which an entity is accorded this right and how this translates into the right to the emission reductions as a commodity (evidence of "right of use"). Rather, the VCS relies on the growing international practice of project implementation and 'carbon right allocation', established under the CDM and elsewhere. Broadly speaking, **a title to the land or to the use of land points to the right of use.** The holder of a title may assign its rights to a third party, which then may assume the right of use and may act as project proponent. In any case, the legal situation will be checked during validation (on that, see below), and project stakeholders are advised to clarify carefully the question of right of use. In case of doubt, a formal right assignment (in writing) will come in handy.

While not a formal step per se, many projects start on the basis of a project idea note (PIN), which lays out the preliminary key characteristics of the project (boundaries, definition of activities, project proponents, the standard used, etc.). In practice, the PIN information often flows from the results of the feasibility assessment and the development of the project design.

The project proponent may prepare the project documentation proper ("Project Document" or PD) on the basis of the PIN. In parallel, it may already open an account with a relevant registry.

Registries are secure platforms where credits are assigned unique serial numbers and which implements any credit transfers and credit retirements. The VCS has two approved registry providers, *APX* (California, U.S.) and *markit* (New York, U.S.).

Once the PD is established, the project proponent has to contract a VCS-approved project auditor, called "validator". The current list of VCS-approved validators shows 44 active entities.[11] The project proponent is free to use any of these that are approved in the AFOLU sector (14 active entities). With a positive report from the validator, the project proponent may submit the project documents for "project registration" with the VCS. The VCS and the registry operator then performs a completeness review and an accuracy review and, if the latter reviews are successful, informs the project proponent of the project's registration.

Once a project is registered, it may generate GHG emission reduction or removal units called Verified Carbon Units ("VCUs"). For this to happen, the project activities must be implemented (implementation may start up to five years prior to registration) and audited ("verified") by an approved third party auditor. Project proponents are free to contract the same entity for both validation and verification. Validation can occur at the same time of verification, however usually validation occurs first, so a project developer can know if their project meets requirements, rather than learning it at a (too) late stage.

The positive verification report needs to be submitted to the VCS together with an issuance request (the first verification report and issuance request are often submitted together with the registration request). The VCS and registry operator, once more, undertake a completeness and accuracy review. If it finds the report and issuance request compete and accurate, it sends a notification to the project proponent requesting payment of the VCU issuance levy. Once this is paid, the relevant VCUs will be issued into the account of the project proponent.

[11] *http://www.v-c-s.org/verification-validation/find-vvb*.

REGISTRATION SUMMARY

1. Start with a Project Idea Note (PIN) – using results of the feasibility assessment and the development of the project design.
2. Develop a Project Document (PD) – project documentation proper – which can be developed on the basis of the PIN.
3. Open an account with a relevant registry (*APX*, California, U.S. or *markit*, New York, U.S.).
4. Contract a VCS-approved project auditor or "validator".
   a. Once validated, submit the project documents for "project registration" with the VCS.
   b. Once the review is complete, VCS will inform the project proponent of the project's registration. The entire validation and registration process may take 0.5-2 years depending on the initial quality of the PD and project complexity.
   c. Once a project is registered, it may generate GHG emission reduction or removal units called Verified Carbon Units ("VCUs").
   d. The project activities must be implemented and audited ("verified") by an approved third party auditor.
   e. The positive verification report needs to be submitted to the VCS together with an issuance request. Once the VCU issuance levy is paid the relevant VCUs will be issued.

VII.

Carbon Markets and Carbon Asset Management

A project developer generating carbon credits ultimately seeks to sell such credits, usually for cash. Selling and buying of carbon credits happens in the carbon markets (there are more than one, see figure 12); the process from credit generation to the distribution of revenues is often referred to as 'carbon asset management'.

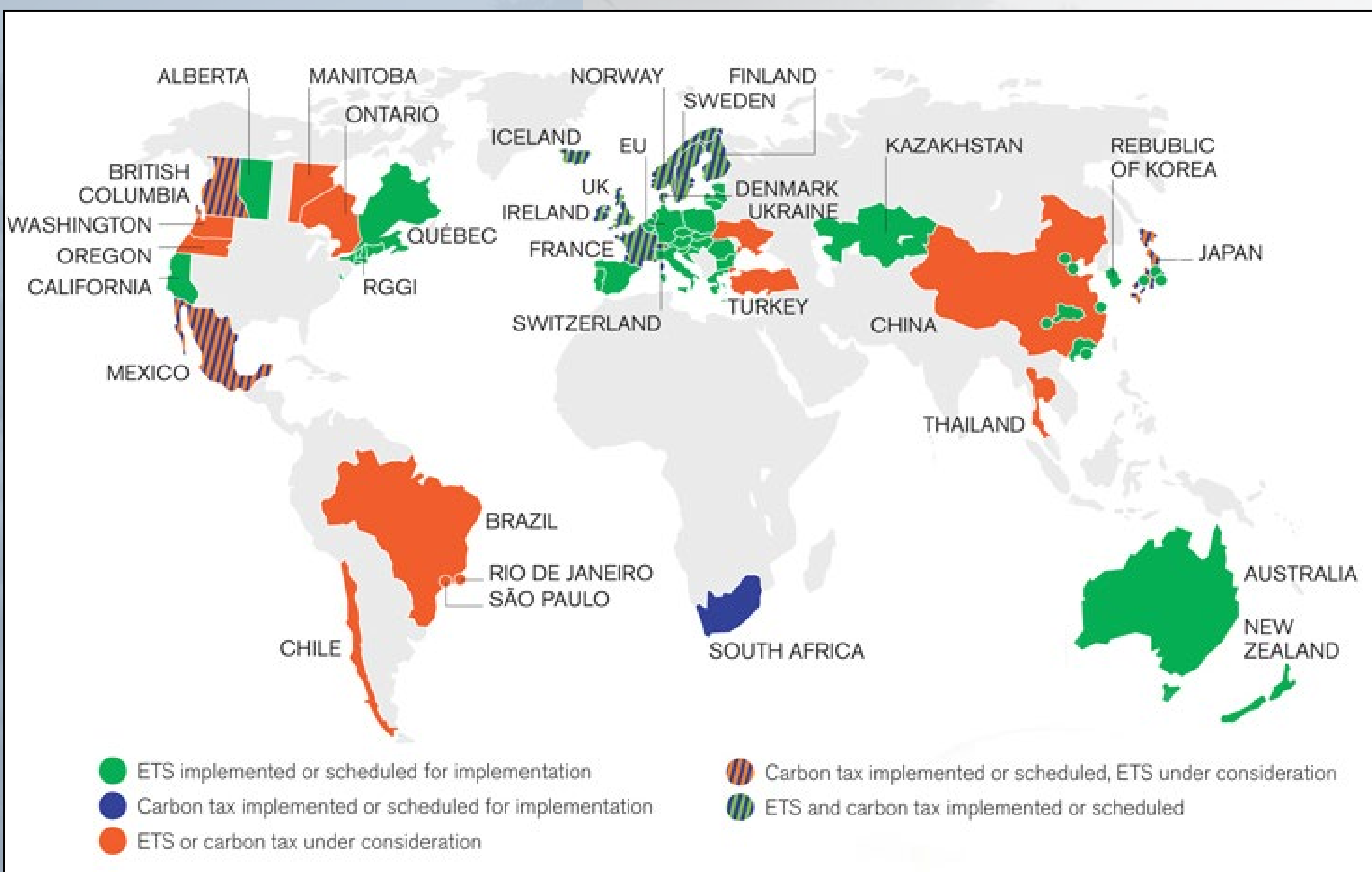


Figure 11. World carbon markets. Source: World Bank 2014.

The key milestones from a carbon asset management point of view are the following:

GENERATION	TRANSACTION	REVENUES
Choosing the standard (VCS, CAR, ACR, Gold Standard, other) and any premium standards (CCBA), where applicable	Open and hold a credit account in one of the applicable registries (for VCS: APX or Markit)	Calculate when carbon revenues are needed (aligned with advance payments, interim payments, on-delivery payments)
Implementing the carbon generation cycle (validation, registration, verification)	Identify the markets the credit type can be sold to and check prices	Make a carbon revenue distribution plan (e.g.,which stakeholders receive benefits at what time) as well as a risk mitigation plan (e.g.,what happens if carbon commodification fails or revenues are late)
Define and/or create the project entity (VCS: 'project proponent'); consider the creation of 'special purpose vehicles' (SPVs) to include different stakeholders	Identify potential buyers (potentially in different markets), possibly with the help of brokers/wholesale traders; public project holders may need to select a buyer through public procurement	Define who is charged with revenue distribution (the project entity/project proponent, a third party, a trust fund model, etc.) and define how funds should be channeled or kept (e.g., within or without certain jurisdictions)
Secure carbon rights (rights to emission reductions) and ensure that double-counting is excluded	Choose the transaction type: ▪ Forward sale (over the counter) ▪ Forward option sale (over the counter) ▪ Spot sale (over the counter) ▪ Spot sale (auction)	Assess the amount of taxes, levies, and transaction costs needed
Issuance of credits	Conclude Emission Reduction Purchase Agreement or ERPA (for forward sales, two-step approach involving term sheet and ERPA phase common)	Receive and distribute funds

Project developers are advised that many activities from the three stages – generation, transaction, revenues – should happen in parallel. There are the early decisions, which are usually made on the basis of the feasibility assessment, namely:

- (Generation) Which standard (and premium standard) to choose;
- (Generation) Who represents the project entity ('project proponent'); whether to create a special purpose vehicle (SPV); and, if so, how to design it;
- (Generation) How to secure carbon rights and how to avoid double-counting;
- (Transaction) What markets are available (for blue carbon credits);
- (Revenues) What are the cash-flow needs; when do revenues need to be available;
- (Revenues) Who is charged with revenue distribution;
- (Revenues) What are the transaction costs (including levies and taxes); and
- (Revenues) What is the contingency (risk mitigation) plan, in case commodification (carbon offset commercialization) fails or revenues are late; who carries the risk.

In the case of blue carbon projects developed under the VCS, the markets available are the voluntary carbon markets (global) and, among the regulated markets, AB 32 (California) and potentially other regional markets – such as Quebec, South Africa, RGGI, South Korea, or China – in the future. Concrete plans are yet to materialize, however.

The cash flow analysis described in chapter 5.5k will project the minimum credit prices needed to implement the project (project-cost approach). In many voluntary carbon transactions, especially in those with direct transactions between project developers and credit end users, the project-cost approach is commonly used to fix the carbon price under the respective contract. Thus, in the project phase immediately following the feasibility assessment, the project developer is advised to:

- (Transaction) survey the relevant markets;
- (Transaction) identify potential buyers; and
- (Transaction and Revenue) verify that prices are achievable > project costs + transaction costs.

In the past, internationally negotiated prices of voluntary credits from wetland projects have been between anything from 5 USD (Belarus) to 90 USD(Germany). It is noted that when entering the regulated markets, divergent project prices no longer apply. Rather, prices become averaged according to relevant auction transactions – in the case of AB 32 (California) this is currently between 9 (non-secured) and 11 (secured) USD per offset.

However, such averaged auction prices from regulated markets are spot (for immediate delivery) or forward (for delivery at a future date), with secured supply (delivery). From the perspective of the project developer, the situation is a different one. Many project developers – especially blue carbon developers – require carbon revenues long before credits are generated, let alone ready for transfer. Thus, even in regulated carbon markets, 'upstream' prices (sales prices agreed prior to or close to generation) between a project developer and a carbon trader or investor remain for negotiation, and the (expected) auction price setting no more than a price ceiling. That means, in a blue carbon relevant example of a project developer who promises at the time of the transaction/signature (Year 0) that he will deliver 1/3 of the sales volume in Year 5 and 2/3 in the Years 6–10 and seeks an upfront payment (to help with project implementation) will find a carbon price that reflects the 'upstream' risk (of delivery failure, late delivery, market depression, etc.) and should, thus, be considerably lower than the ('downstream') price on delivery.

The transaction itself is done in a contract, which goes by the name "Emission Reduction Purchase Agreement" or ERPA. There are open source models available, including those which address specific risks of project developers.[12] Project developers are advised, however, to work with legal experts, in particular if the project is 'upstream' (i.e., holds specific risks), includes a complex funding model, or where relevant transaction experience does not yet exist.

The transaction itself usually says little about revenue sharing models. In land-use based and blue carbon projects you will often find constellations, in which a large number of stakeholders (including local populations) will benefit from the carbon revenues. The rules for the benefit sharing – who has access to what share and when, in compensation for what – remain a matter between the project developer (the project proponent under the VCS, which may be a dedicated special purpose vehicle (SPV)) and the project stakeholders. It is, of course, of fundamental importance for the success of the project and requires careful planning and transparent (usually also contractual) arrangements.

[12] *See the CERSPA initiative, cerspa.com.*

Box 13. Snohomish Estuary: Project Proponent

Wetlands restoration activities in the Snohomish have so far taken place on a piecemeal basis as opportunities for land purchase arose. Proponents have been varied, including the Tulalip Tribe, City of Everett, Snohomish County agencies, and private entities (mitigation bank). Funders have ranged from Federal, State, local, and private funds. The activities undertaken have fallen under a range of Federal, State, and County planning activities.

An important ongoing initiative in the region is the Snohomish County Sustainable Lands Strategy. Under this strategy, it is recognized that both farming and salmon production play an important role in the history, culture, and economy of Snohomish County and both can be protected through sustainable lands projects.

A blue carbon project boundary could be set that covers a regional area both of the tidal reaches of the estuary and the lower stretches of the floodplain subject to future tidal reach; however a project proponent will be needed that connects across the regional community and that can also connect to different levels of government, to funding opportunities, technical capacity, and liaise with regulators. A private or non-profit entity could take on this role, as could an entity such as County government. Taking the example of the Snohomish County Sustainable Lands Strategy, this could be expanded to include discussion and planning of community climate change adaptation and mitigation needs and opportunities. By engaging with land owners within this wider discussion, it could bring a forum for increased understanding of what climate change means for them and their options for engaging either through maintaining agricultural practices, perhaps with additional climate change reduction practices as appropriate, allowing for wetlands or forestry projects on their lands.

VIII.

Grouped Projects: Applicability and Recommendations

1. **Introduction**

Land-based climate change mitigation projects of modest size are known to suffer from considerable transaction costs and scale-related risks, thwarting their development or undermining their sustainability. In many cases, these activities would individually be too small to embark on carbon development or conversely too large to develop all in one go. For example, estuary restoration may easily span large territories with numerous land owners. Simple pooling of similar projects creating scale may overcome some of the bottlenecks, but the creation of so-called "grouped projects" under the VCS has additional benefits as well. It creates flexibility in the time of inclusion of areas and kinds of activities, as the where and when does not need to be known exactly in advance. A non-grouped project, once registered (or validated), may not be converted into a grouped project, for example when a project proponent wants to add new project areas. Therefore, **one should assess early in the process whether or not to develop a grouped project** providing for the option to gradually expand the project by way of adding so called "project activity instances" over time.

While managerial, financial, and legal structures may become more complicated than in individual projects, solutions for grouped projects have been explored and tested in various existing examples similar to grouped projects. One such example is the Programmes of Activity (PoAs) under the CDM and the Gold Standard. This chapter analyzes certain key features of the grouped project approach, sometimes also referred to as "programmatic approach", and discusses the management of grouped projects and options for their financial and legal structure based on the Snohomish example.

The following publication provides helpful reading of principles and key recommendations for PoAs, including recommendations for general, financial, and legal management:

- The Handbook for Programmes of Activities: Practical Guidance to Successful Implementation, 2nd Edition (Climate Focus 2013)

2. VCS Rules for Grouped Projects

The VCS rules for grouped projects are spelled out in the VCS Standard. The following is a summary of the main requirements.

A grouped project assembles a flexible number of "project activity instances", the latter being defined as a "particular set of implemented technologies and/or measures that constitute the minimum unit of activity necessary to comply with the criteria and procedures applicable to the project activity under the Methodology applied to the project".

The validation process focuses on a single (initial) project activity instance, which will serve as the model for all project activity instances to come in the future. At the same time, several top-level features are laid out in the "project description", namely the geographic areas within which new project activity instances may be developed, as well as general eligibility criteria for their inclusion (see below checklist). The project description may define one or more geographic areas, which are always homogeneous with respect to the baseline scenario, additionality and non-permanence risk; these are initially determined in the model project activity instance. Note that new geographic areas may be included over time, provided it can be demonstrated that such areas are subject to the same (or at least as conservative) baseline scenario and additionality test as the initial project activity instance.

CHECKLIST FOR GROUPING PROJECT ACTIVITY INSTANCES

Project descriptions provide the eligibility criteria for the inclusion of new project activity instances. The criteria ensure that new project activity instances will form a coherent part of the project as a whole. Any project activity instance must:

1. Meet the applicability conditions of the GHG accounting Methodology applied;
2. Apply the pre-fixed technologies or measures specified in the project description;
3. Have the baseline scenario determined in the project description for the specified project activity and geographic area;
4. Have characteristics with respect to additionality that are consistent with the initial instance(s) for the specified project activity and geographic area; and
5. Comply with the model leakage assessment.

The inclusion of new instances happens over time, as part of a new verification. This implies that if a project proponent chooses to have the project validated and verified at the same time (which is a possibility under VCS rules), with no further monitoring and verification events anticipated, no new instances could be added to the project, rendering the grouped project structure impractical.

Because evidence of right of use for a new project activity instance must only be held by the project proponent from the moment the instance begins generating emission reductions (i.e., its start date), grouped projects may be developed and validated without having the necessary contractual agreements in place with land owners relevant for the new future instance. This may provide considerable flexibility in the development and implementation of the project. A new project proponent may be added with a new project activity instance after the grouped project is registered, provided that this occurs within five years of the project activity instance start date.

Box 14. Jurisdictional and Nested REDD+ (VCS JNR)

The Jurisdictional and Nested REDD+ (VCS JNR, see www.v-c-s.org/JNR) approach aims at the implementation of REDD+ at the subnational or 'jurisdictional' level, while regulating the integration of REDD+ project activities within higher-level jurisdictional REDD+ projects ("nesting"). The VCS JNR comes in different formats. It may, but does not necessarily, exclude crediting of (grouped or non-grouped) project-level interventions. Rather, it may offer an infrastructure for jurisdictions for project-level approaches giving guidance on baselines, providing Measurement, Reporting, and Verification (MRV) and facilitating direct crediting to projects. 'Jurisdiction' is not to be understood as being restricted to the concept of domestic constitutional law. The VCS defines it as the "administrative unit such as a nation, state, province, region, department, or district, or an eco-region or other defined area, specified in the jurisdictional project".[13]

The VCS JNR has not yet been made fully compatible with the WRC. Its flexibility to target entire "eco-regions" makes the development of a "jurisdictional and nested WRC" from a coastal wetland perspective a priority (see box 6 in chapter 5).

3. Experience in VCS land use categories

The VCS to date has registered three grouped projects in the land use sector. One of them is the Lower Mississippi Valley Grouped Afforestation Project of The Nature Conservancy (TNC). This project is converting degraded land to forest by paying for restoration costs, as well as purchasing permanent conservation servitudes (easements) in exchange for carbon payments. In return, landowners receive income additional to that provided by the already existing USDA (U.S. Department of Agriculture) conservation program. The project is targeted at landowners who would not have enrolled without the additional funding provided by the grouped project. The initial project activity consists of 89.4 ha comprised of multiple fields (30 in total, mostly catfish ponds which were drained prior to landowner's decision to enroll in the grouped project). Additional areas will be added to this project over time as TNC acquires additional conservation servitudes. While landowners keep hold of their land, land use rights in the project area are restricted through such conservation servitude, designed to protect the integrity of, amongst others, forest carbon stocks. The project areas will be monitored annually for compliance with conservation servitude restrictions. While the conservation servitude has a permanent nature (which is neither a VCS nor a general grouped projects requirement), the crediting period for the carbon project is 32 years (30 years being the minimum for an AFOLU project to meet longevity and permanence requirements – see chapter 4.3 on risk management). The project has reserved the rights to the carbon credits in the project area through an "Assignment of Carbon Rights" in conjunction with a "Grant of Conservation Servitude and Rights of Use". The grouped project is thus based on two types of contracts and managed by a group manager who determines the inclusion of additional areas (instances) based on a set of eligibility criteria set out in the project description.[14] In accordance with the VCS requirements for grouped projects, all new instances will:

1. Meet the applicability conditions set out in the GHG accounting Methodology. This is the VCS-approved UNFCCC methodology AR-ACM0001 "Afforestation and Reforestation of Degraded Land;"[15]
2. Use the technologies or measures specified in the project description and apply these in the same manner as specified, involving the application of machine or hand planting, with or without site preparation, of native bottomland tree species, and no use of flooding irrigation as part of the project activity;
3. Be subject to the baseline scenario determined in the project description for the specified project activity and geographic area; and
4. Have characteristics with respect to additionality that are consistent with the initial instance for the specified project activity and geographic area (e.g., the new project activity instances have financial, technical, and/or other parameters consistent with the initial instance, or face the same investment,

[13] *VCS Program Definitions, v3.5 (8 October 2013).*

[14] *www.vcsprojectdatabase.org: Project ID 919.*

[15] *Currently abolished and replaced by AR-ACM0003 "Afforestation and Reforestation of Lands except Wetlands" available at cdm.unfccc.int/methodologies/ARmethodologies/approved.*

technological, and/or other barriers as the initial instance)[16].

The project description provides a map with the grouped projects' geographical boundary within which all project activity instances will be located. The pre-existing land use within the geographical boundary is degraded pasture/grassland, cultivation of annual crops with or without fallow periods, and abandoned non-forest lands which have previously been in agriculture. For any new project activity instance included, the baseline scenario and additionality do not need to be examined anew. Compliance is pre-set on the basis of the project boundary description and the application of the "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities."[17] Note that for coastal wetland projects in the U.S. a standardized approach to additionality can be employed, as outlined in chapter 5.4.

4. The institutional and legal dimension

Overall, the technical tasks of moving through the carbon development cycle (validation, registration, and verification) for a group project are not more challenging than they are for a stand-alone carbon project. The eligibility criteria have to be defined and tested in both cases (grouped and stand-alone). The benefits of the grouped approach are obvious in the situation in which the project area is intended to expand over time. Then the inclusion of new project activity instances is a lot simpler and less costly than duplicating the initial effort of registering a new project.

A level at which a grouped approach may prove more difficult than a stand-alone project may be with respect to governance/institutions and law. While a grouped project may add new proponents with any new project activity instance, the main institutional structure linking (and controlling) the various instances should be centered in *one* institution acting as the grouped project's aggregator. The CDM calls the aggregator the coordinating or managing entity (CME). The VCS has not reserved a certain terminology and is absent of any details or task description an aggregator would have to play.

The aggregator is typically the person or institution that acts on the initial project activity instance and is responsible for the development of the core grouped project structure. It thus needs to be in control of the initial project activity and establish the respective ownership ("right of use").[18] When the grouped project grows, it needs to promote and manage the continuous carbon development cycle. In that process, it may be supported by other (new) project proponents, but it is ultimately the aggregator who decides on new inclusions, assesses (or have assessed) compliance with the project description, procure evidence of "right of use", and importantly organizes the sale of carbon offsets and the distribution of carbon revenues.

a. Types of Aggregators

There is no natural institution or 'institutional type' to assume the role as aggregator. The experience of both the VCS and the CDM suggest that a grouped project can be successfully run by public agencies (including government departments), not-for-profit organizations, or commercially organized special purpose vehicles (SPVs). Each time, the specific choice should be made on the basis of key project characteristics and the participatory needs and capabilities of stakeholders. This can (and usually should) happen at the stage of the feasibility assessment.

One of the key considerations is the number of landowners, residents, and users (for farming, fishing, tourism, etc.) across the potential project area. If the entire area is in the hand of a single owner and user (e.g., a farmer, a national or local government, or a not-for-profit organization), then the question is solely one of internal organization. A government may have the staff, expertise, and infrastructure to run the project through one of its departments, and yet it may see the need to outsource this function to a separate agency or a (perhaps government-owned) commercial entity. This outsourcing may be preferable because the operations are not regarded a government task per se, because the governance process is too slow or cumbersome to meet the needs of the project, or simply because it cannot directly engage in activities that involve the commercialization of carbon credits.

If the potential project area is in the hands of many, participatory involvement is vital. Then a cooperative may be a good solution, especially when the distinct stakeholders have a record of successful cooperation. If such record does not exist and/or if the appetite of

[16] *This is not relevant for projects on the "positive list" under the standardized procedure for additionality.*

[17] *cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf*

[18] *See VCS Project Requirements, version 3.2, paragraph 3.12.1 (February 2012). For the context see chapter 7.*

stakeholders to become directly involved is not high, a third-party management model – for instance in the form of an NGO or a dedicated SPV that interacts with landowners through carbon-credit-for conservation agreements – is more realistic.

Specific challenges may arise when land ownership is split between government-held and private land. Bundling interests in a joint venture, then, is often a novel approach, which will meet with reservations on all sides. A solution may be the creation of a dedicated trust fund or the pre-organization of all private owners in one cooperative or SPV and a bilateral arrangement between it and the government department concerned.

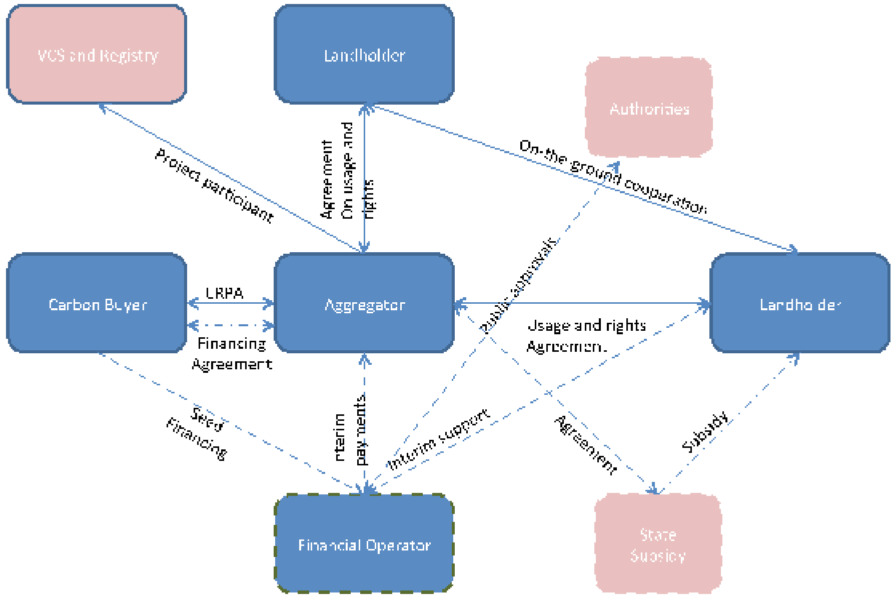


Figure 12. The role of the aggregator in a grouped land-use or blue carbon project. Source: Silvestrum 2015.

Whatever the concrete institutional structure, stakeholders must ensure fully operational and continuous project management and a sufficient level of both methodological and carbon asset related expertise throughout the process.

b. Legal Implications

Grouped projects have a number of legal and contractual ramifications. The larger the number of project activity instances, the more complex the legal setting, and the greater the need or expectation to hold a variety of strong contracts in place. This concerns the level of project proponents (among themselves, including regarding risk allocation and liabilities, in case a project instance becomes a net emission source, which will affect credit generation for other project instances); the relationship between landowners or landholders and the aggregator; the relationship between the aggregator and public entities in charge of waterways, water supply, fishing, construction, environmental protection, and so forth; and the transaction partners (whereby the aggregator usually acts as centralized "carbon seller" towards the "carbon buyer", representing all other proponents). For a graphical overview see figure 13. The aggregator will also be the natural focal point for any co-funding authorities and donor entities and, as the case may be, financial operators assisting with seed, advance, and interim payments.

5. Financing schemes for grouped projects

We explained that carbon finance (see chapter 7) rarely presents the sole or major financial source. Rather, it offers additional funding to leverage other sources of finance and to bring continuous income to cover running costs (for staffing, monitoring, verification, servitudes, etc.) over the crucial first decades. Carbon finance may also secure seed (advance) financing for operational works through the use of carbon forward sales.

It is an important part of the feasibility assessment to examine robust financing options. Given the specificities of ecosystem interventions – conservation does not yield immediate returns in the way an energy efficiency project does through lower costs – a large number of projects will often rely mostly on subsidy funding than on equity investment or debt financing. Note that subsidies do not necessarily need to come in the form of cash. They may come in the form of in-kind (land) donations, servitudes, construction compensation, or clean water supply mechanisms, among others. The New York City Watershed Program is a prominent example for wetland sensitive protection and management subsidies.

Interestingly, there is an increasing interest among development banks but also investors and sustainability funds to provide equity or debt for ecosystem conservation and/or restoration.[19] The investment returns, then, target revenues from a wide variety of payment for ecosystem services schemes. Successful wetland restoration, for instance, may yield revenues from compensation programs, conservation agreements with water utilities, hunting and fishing leases, and tourism.

In many developing countries, where wetlands are used for subsistence farming, micro-finance schemes with continuous payments to a wide range of stakeholders will be of particular importance.

A carbon project will (and should) usually not be put in practice before financial closure is reached. The development of a detailed business plan outlining the different sources of finance must, therefore, be among the first steps to be taken in any project. A simplified project finance structure can be found in figure 13.

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[19] *Forest Trends, Taking Stock: Payments for Forest Ecosystem Services in the United States (2011), accessible at http://www.forest-trends.org/documents/files/doc_2673.pdf; UNEP, Biodiversity and Ecosystem Services. Bloom or Bust? (2008), accessible at http://www.unepfi.org/fileadmin/documents/bloom_or_bust_report.pdf; Hartwell, R. et al., Financing Mechanisms that Advance Ecosystem Service Markets and Promote Rural Sustainability (Institute for Natural Resources, Oregon 2010).*

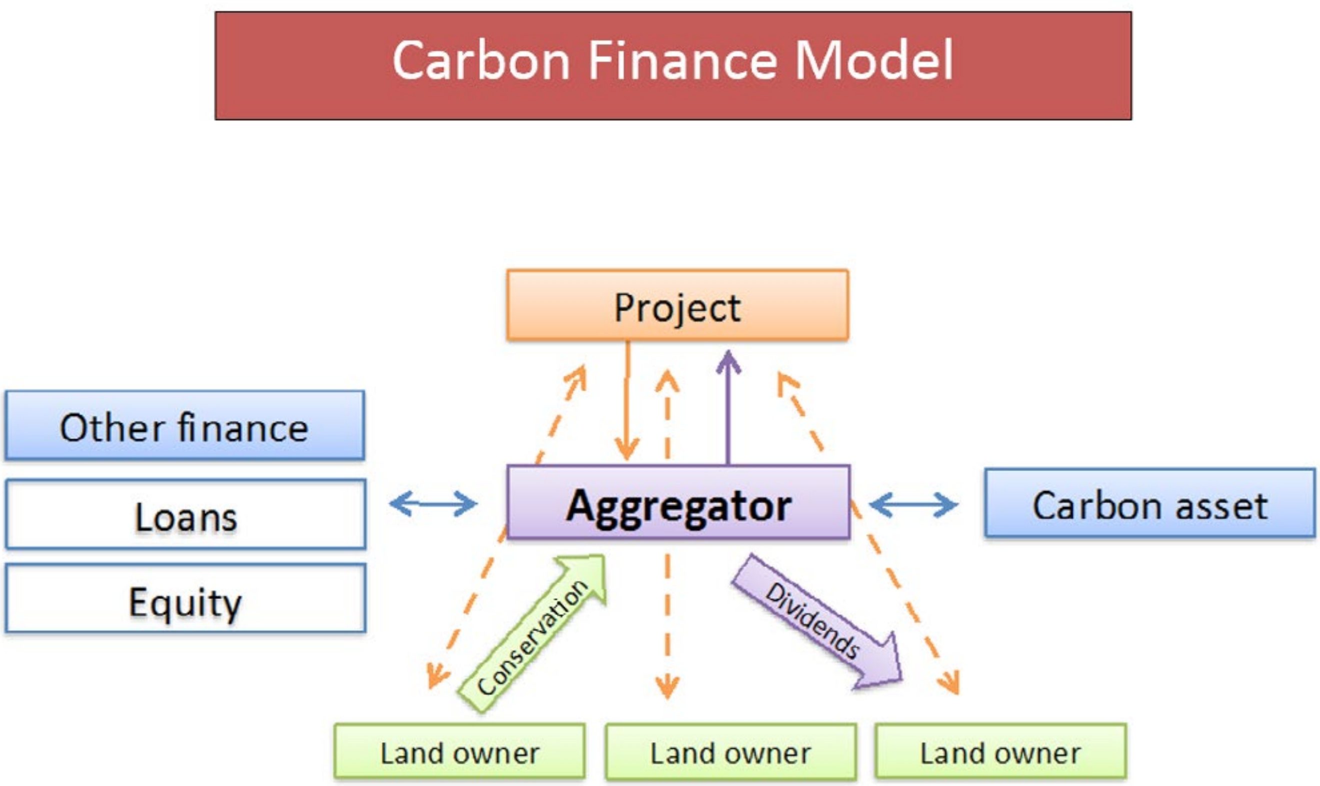

Figure 13. Project finance structure.Source: Silvestrum 2015.

Box 15. San Francisco Bay

The San Francisco Bay estuary is the largest on the west coasts of North and South America. The estuary has suffered some of the most extensive degradation of any estuary in the U.S., with conversion of more than 95% of intertidal wetland area 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, loosely assembled in the "San Francisco Bay Joint Venture".

The San Francisco Bay Joint Venture has taken steps to link dredging projects with wetland restoration projects (to date, 7 million m^3 of dredged material has been reused to build wetlands).

Within San Francisco Bay, the South Bay Salt Ponds Project (SBSP) of 15,000 acres in size involves more than 50 individual tidal wetland restoration projects (akin to "instances"). Because of the complexity of the project and the long project implementation timeline of 50 years, a science-driven adaptive management planning process has been developed through which each phase of the project will be evaluated and adjusted, based upon tracking of site recovery against modeled projections. The design of the overall project allows for adjustment in the mosaic of wetlands that will be restored in the future based upon this learning. Recognizing this planning approach, the South Bay Salt Ponds Project is also one of the first examples of approval of program-level environmental regulatory approval (known as an Environmental Impact Statement / Report). Typically, such approvals are provided on a project-by-project basis. But in this case a program-level evaluation of the long-term alternative restoration plans, as well as a project-level evaluation for the first phase of project development were developed.[20] The project provides an example of the planning process to deliver a programmatic environmental documentation that would support similar scale grouped coastal wetlands carbon projects.

[20] *www.southbayrestoration.org/EIR/*

IX. Appendix

ACCOUNTING FOR SEA-LEVEL RISE: COASTAL WETLAND RESTORATION SCENARIOS

In this appendix we have applied the Methodology to proposed calculations of emission reductions in four simple characteristic scenarios of coastal wetlands restoration:

- Scenario A: Restored mangroves resilient to sea-level rise;
- Scenario B: Restored mangroves in vulnerable locations that drown upon sea-level rise at t = 80 years, with no tree harvesting;
- Scenario C: Spruce afforestation on floodplains, frequently flooded by tidal fresh water, then harvested before permanent flooding at t = 80 years; and
- Scenario D: Spruce afforestation on conserved degraded floodplains where wetland builds up after 80 years due to sea-level rise.

In this section we will:

a) Illustrate approaches for assessing the amount of carbon within an assigned carbon crediting period; and

b) Provide an illustrated narrative describing options for including transitional habitat projects (forest to wetland) as part of a landscape-scale project that builds resilience to sea-level rise.

Also illustrated is the important point that wetlands projects in areas vulnerable to near-term drowning or erosion will not make good carbon projects, unless as a temporary element within a larger landscape project.

Summary of applied methodological procedures

For projected carbon storage in trees one may apply tree growth and stand development models.

Where biomass is submerged, it is assumed that this carbon is immediately and entirely returned to the atmosphere (after subtraction of the carbon stored in harvested wood products). In cases of submergence, the maximum carbon stock in tree biomass used for the estimation of emission reductions is limited to the long-term average carbon stock over 100 years.

Carbon stored in products of harvested wood prior to submergence is estimated using data for various wood fractions from Winjum et al. 1998.

For carbon accumulation in mineral soils of restored coastal wetlands we used the default value of 1.46 t C $ha^{-1}yr^{-1}$ provided by the Methodology (see section 8.1.4.2.3 "Default factors" in the Methodology).

The eligible CO_2 emission reductions in soils are maximized at the difference in carbon stock between with-project scenario and baseline scenario at $t = 100$.

Assumptions and simplifications

For the purposes of illustration, the following assumptions and simplifications were made as examples:

- Baseline carbon in biomass is absent;
- Carbon sequestration in mangrove biomass is according to default value from IPCC (Wetlands): aboveground biomass growth 9.9 t dm $ha^{-1}yr^{-1}$, carbon fraction 45.1%, maximum biomass 192 t dm ha^{-1};
- Using the Snohomish estuary with the examples, carbon sequestration in Sitka spruce is according to an S-curve in Raymond & McKenzie 2013: maximum biomass 250 t C ha^{-1};
- Carbon stored in harvested wood products is 18% of carbon harvested;
- Carbon in mineral soil at $t = 0$: 100 t C ha^{-1} (in upper 1 m of soil column);
- Eroded carbon upon drowning: baseline 5% and project 1%.
- Oxidation constant of eroded carbon[21] in the baseline: 0 (therefore baseline carbon in soil is 100 t C ha^{-1} throughout the accounting window of 100 years, irrespective of drowning period);[22] and
- Oxidation constant of eroded carbon in with-project scenario: 1.[23]

[21] *In areas with wave action, sediment will erode and carbon will be removed. It is one of the great challenges for the development of a conservation methodology to determine how much of this carbon will be oxidized and returned to the atmosphere versus how much will be re-sedimented and stored. For this example, for the baseline one may conservatively assume that all eroded carbon is oxidized. The opposite is true for the project scenario. Whether this overburdens the conservation project depends on a number of factors. These include the point in time when submergence and erosion begins (which may be different for the baseline and project scenario), the amount of carbon that erodes upon submergence (this also may be different for the baseline and project scenario), and the oxidation rate of eroded soil organic matter. In the most conservative approach, the oxidation constant is 0 for the baseline and 1 for the project scenario.*

[22] *Here we are being very conservative. We assume that any carbon in tidal wetlands that erodes does not go back to the atmosphere, and, therefore, a project cannot get credit for preventing erosion.*

[23] *This implies that, very conservatively, all carbon eroded from the restored wetland goes back to the atmosphere. Project proponents may justify a smaller oxidation rate based on appropriate scientific research.*

Results

General

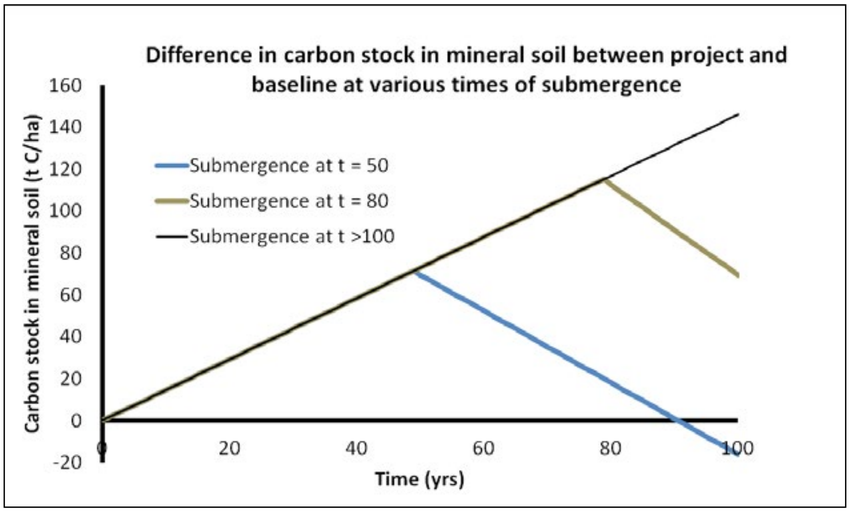

Figure A1. Projections of the difference in carbon stocks in mineral soil between project and baseline in three scenarios of submergence and erosion. The differences between project scenario and baseline at t = 100 are -18, 70 and 146 t C ha-1.

Soil carbon stocks increase at a constant rate of 1.46 t C $ha^{-1}yr^{-1}$ as provided by the Methodology. Once submergence occurs, carbon is lost at a rate determined by loss of area annually (set for the purpose of this analysis at 5% and 1% for baseline and project, respectively).

In the baseline scenario, soil carbon remains constant at 100 t C ha^{-1}, independent of time of submergence. This is due to the conservative oxidation constant of 0. With submergence after 50 years in the project scenario, the difference with the baseline scenario becomes negative at t = 100, hence yielding no emission reductions. This is due to the conservative oxidation constant for eroded carbon of 1 for the project scenario.

This highlights the impetus for science to improve these coefficients. It also should incline project developers to conceive restoration projects resilient to sea-level rise.

Figure A2 illustrates the effect of the rule that the maximum amount of credits from soil is capped at the difference in soil carbon stock between project and baseline at t = 100. The maximum of 70 t C ha-1 yr-1 is already reached at t = 48 and at this point, therefore, the emission reductions that can be claimed drop from 1.46 to zero.

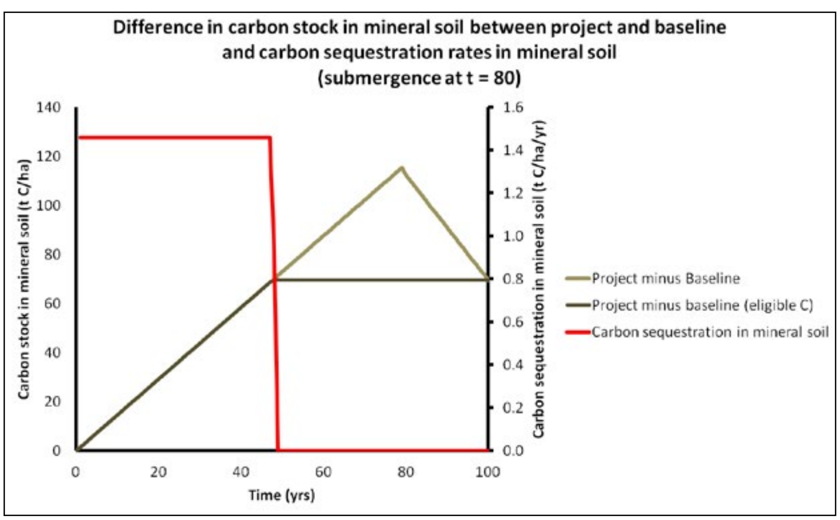

Figure A2. Projections of net carbon sequestration in mineral soil in case of submergence at t = 80; 'eligible' denotes the trend capped at the difference between project and baseline at t = 100. The red line shows the annual emission reductions.

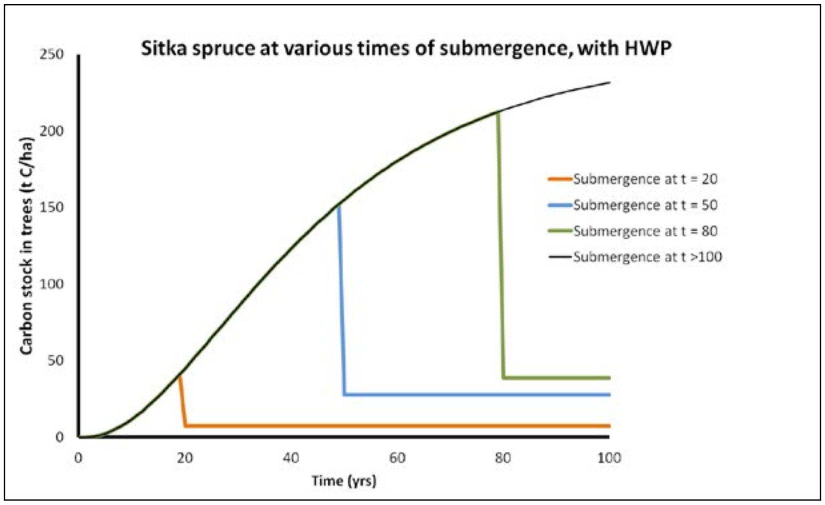

Figure A3. Projections of the difference in carbon stocks in tree biomass between project and baseline in 4 scenarios of submergence. The related long-term average carbon stocks are 9, 47, 98, and 136 t C ha^{-1}.

In biomass, the eligible emission reductions are maximized at the long-term average over 100 years. The later drowning occurs, the greater the emission reductions yielded by carbon sequestration in trees.

The cutback of eligible emission reductions due to submergence is attenuated by 18% (see assumptions) by accounting for harvested wood products (HWP).

<u>Scenario A: Restored mangroves resilient to sea-level rise</u>

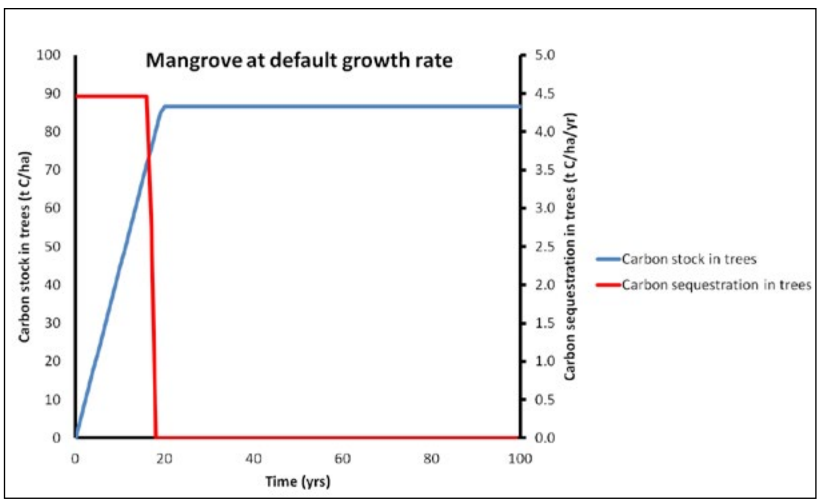

Figure A4. Projection of carbon stock and carbon sequestration in mangrove biomass, without a submergence scenario.

Annual carbon accumulation in tree biomass is at 4.5 t C ha^{-1}yr^{-1} based on IPCC default values, an option provided by the Methodology. Locally derived S-curves may be applied as well. The used model generates emission reduction during the first 20 years, after which the maximum biomass in trees in attained. The last decade in a crediting period of 30 years[24] would not generate carbon credits from biomass.

Net carbon sequestration in mineral soil follows the black line in figure A1 – a steady increase by 1.46 t C ha^{-1}yr^{-1}, not interfered by future submergence, and continuing beyond the period of emission reduction due to biomass carbon sequestration and a crediting period of 30 years.

[24] *The minimum period required for AFOLU projects to meet the criteria of the non-permanence risk assessment.*

Scenario B: Restored mangroves in vulnerable locations: restored mangroves that drown upon sea-level rise at *t* = 80 years: no tree harvesting

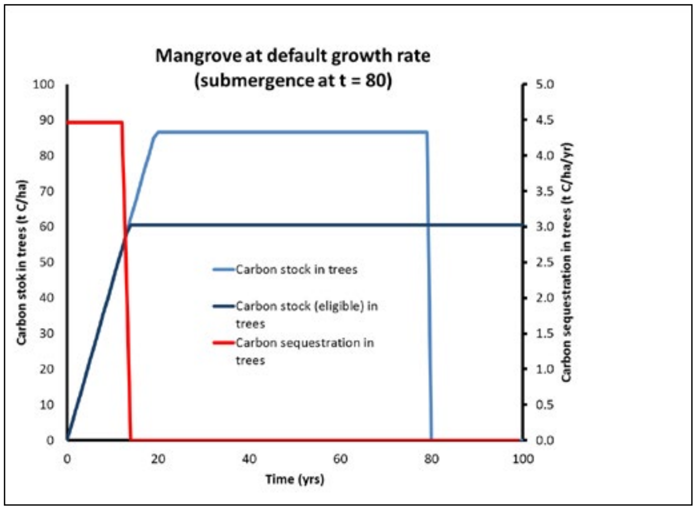

Figure A5. Projections of carbon sequestration in mangrove biomass in case of submergence at t = 80; 'eligible' denotes the trend capped at the difference between project and baseline at t = 100. The red line shows the annual emission reductions.

Net carbon sequestration in mangrove biomass lasts shorter than in Scenario A due to the fact that the maximum is capped at 60 t C ha^{-1}, reached in year 14.

As in scenario A, carbon sequestration in mineral soil follows the green line in figure A1 – a steady increase by 1.46 t C $ha^{-1}yr^{-1}$ until year 80, then a decline, still resulting in 66 t C ha^{-1} at *t* = 100. At the end of a crediting period of 30 years the mineral soil would have net sequestered 44 t C ha^{-1}.

Scenario C: Spruce grows on upper fringes of restored wetland, frequently flooded by tidal fresh water, then harvested before permanent flooding at *t* = 80 years

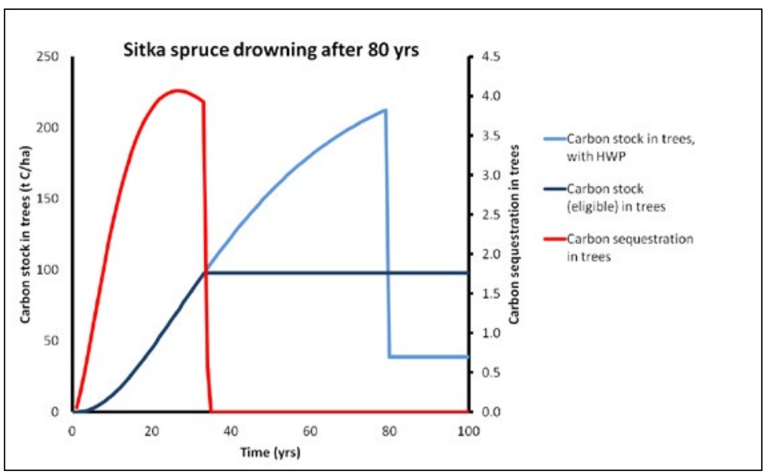

Figure A6. Projections of carbon sequestration in Sitka spruce biomass in case of submergence at t = 80; 'eligible' denotes the trend capped at the difference between project and baseline at t = 100. The red line shows the annual emission reductions.

Net carbon sequestration in spruce biomass is capped at 98 t C ha^{-1}, reached in year 34. A crediting period of 30-35 years is therefore appropriate for capturing these carbon benefits.

Net carbon sequestration in mineral soil follows the green line in figure A1 (see scenario B for a description).

Scenario D: Spruce grows on conserved degraded wetland and then wetland builds up after 80 years due to sea-level rise

Carbon sequestration in spruce follows Scenario C but net carbon sequestration in mineral soil due to wetland restoration (figure A1) is delayed by 80 years. The buildup of wetland soil does not yield carbon credits in the crediting period if this is set at 30 years because it does not affect the results for this period. However, it supports the story of resilient and sustainable projects in the face of sea-level rise and may provide collateral when attracting funding streams for wetlands restoration.

X.

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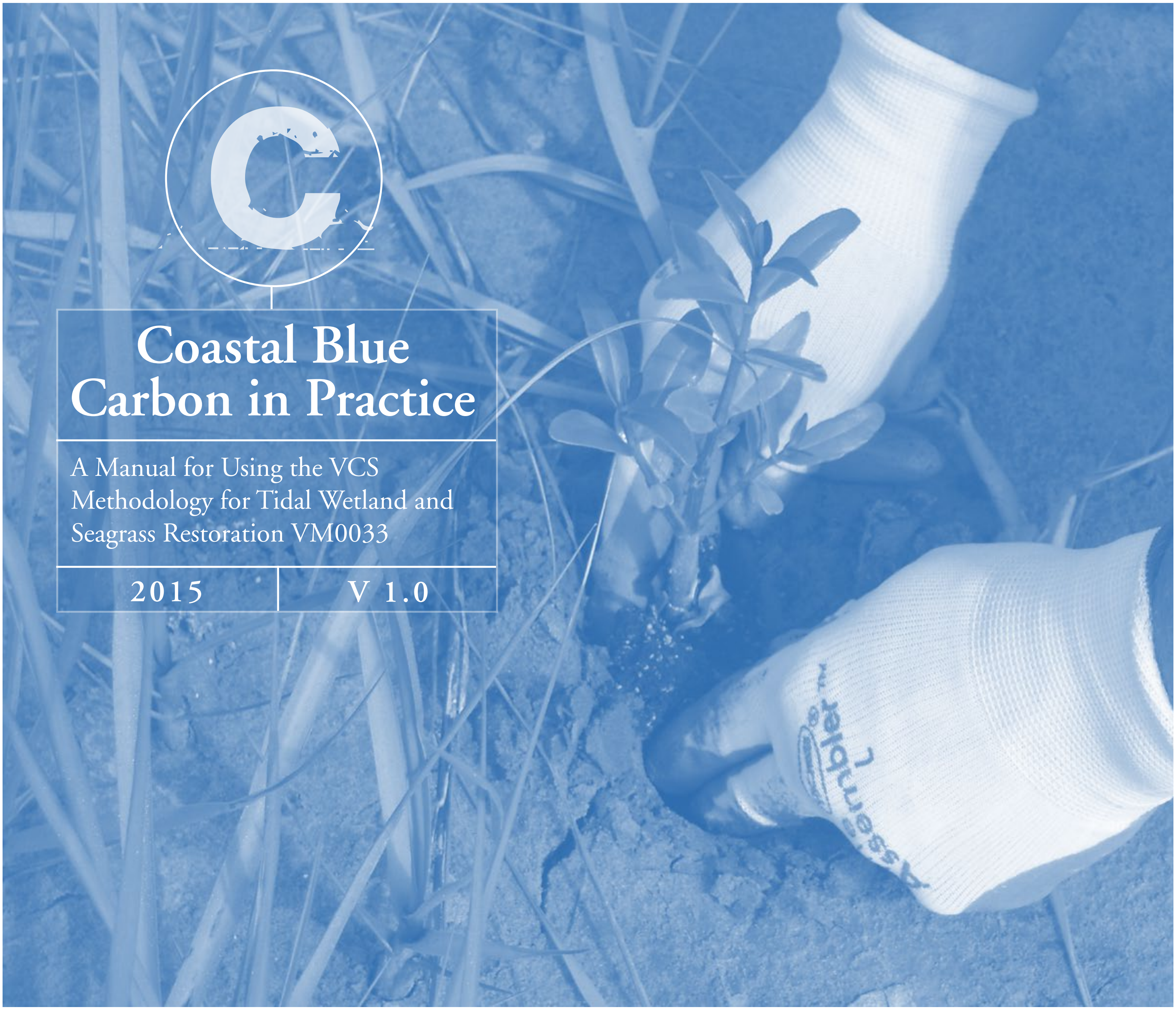

Coastal Blue Carbon in Practice

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