Coastal Blue Carbon as an Incentive for Coastal Conservation, Restoration and Management: A Template for Understanding Options

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What Is Coastal Blue Carbon?

Coastal Blue Carbon refers to the climate change mitigation benefits offered by the improved management through conservation and restoration of biogeochemical processes performed by coastal wetlands, including salt marsh, mangroves, seagrasses, and other tidal wetlands. Coastal blue carbon is the newly recognized ecosystem service value of climate mitigation, and as such can provide a new incentive to prioritize the restoration and conservation of these coastal ecosystems.

These habitats provide important ecosystem services, such as habitat for fish, wildlife, and sensitive species; storm and flood protection; improved water quality; and jobs and economic benefits. Maintaining these functions is critical to supporting coastal ecologies and communities. These services provide an important component to support adaptation to climate change and protection of coastal communities.

On a per-acre basis, coastal habitat restoration and conservation can provide among the greatest climate benefits compared to forest or other land use projects (Costanza et al. 1997).

Market and Non-Market Incentives

The global community is establishing a range of policy and management approaches at many levels to address climate change and reduce GHG emissions. These approaches may involve financial incentives, such as carbon financing, to encourage reductions in emissions. Other mechanisms might include changes in laws to strengthen conservation, or adjustment to funding streams or subsidies to adjust land use practices.

In some cases, wetland management project opportunities, including conservation and restoration, will have substantial climate mitigation benefits and therefore be strong candidates for entering carbon markets. Other projects, while providing climate mitigation benefits, will be better suited to non-market incentives. The climate mitigation benefits of coastal ecosystems are significant, and the challenge now is to translate these newly recognized values which stimulate an increase in the scale and pace of conservation and restoration.

The Science and Management of Coastal Blue Carbon

There are three greenhouse gases to consider: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20). To help assess management options that may have GHG benefits, the following summary of emissions, potential emission reductions, and atmospheric removals, is provided:

Carbon dioxide (CO_2)

Tidal marshes, mangroves and seagrasses extract CO_2 from the atmosphere and store carbon within plant biomass. Over time this carbon is transferred to the soil carbon pool, and plant material, particularly root material, decays in situ. Coastal wetlands continuously sequester carbon in soils as wetlands build with sea level rise, burying old soil beneath new. Carbon sequestration benefits accrue when a functioning wetland habitat is conserved and maintained, when a former or degraded wetland is restored, and when a wetland is created where none existed prior to creation. The conditions of carbon sequestration are a functional wetland with native plants and appropriate hydrology and sediment conditions.

The long term sequestration of carbon within wetland soils has resulted in enormous stocks of carbon building up beneath coastal wetlands (Pendleton et al., 2012). Wetland soils are rich in carbon compared to other ecosystem types. If undisturbed, these stocks will remain buried. Drainage of wetlands results in a rapid emission of CO_2 through oxidation (Crooks et al., 2011, Pendleton et al., 2012). Climate mitigation benefits occur when wetlands at risk of drainage or disturbance are protected. And restoring hydrology to a drained wetland that is emitting CO_2 can reduce emissions as well.

Methane (CH_4)

Wetlands naturally produce CH_4, a greenhouse gas with a global warming potential 25 times greater than CO_2. Highly variable in wetland systems, methane emissions are limited in higher salinity systems. Where salinities exceed 20 parts per thousand, methane emissions are insignificant. Restoring tidal flow may in some cases increase salinity above the threshold, thereby providing a reduction in methane emissions. Restoring a site below the salinity threshold could result in new methane emissions, and these should be quantified and weighed against the greenhouse gas benefits to accurately predict the overall climate mitigation benefits of a project.

Nitrous oxide (N_2O)

N_2O is a naturally occurring gas in wet soils, exacerbated by anthropogenic nitrogen pollution. N_2O has a global warming potential 310 times greater than CO_2. Creating or restoring a wetland where none exists may result in an increase in N_2O emissions where nitrogen pollution has deteriorated water quality. Improving water quality to enhance and restore seagrass beds could decrease N_2O emissions.

Coastal Blue Carbon Tools

Carbon markets exist to encourage and/or require individuals, governments, businesses, and others to reduce or offset their GHG emissions. *Standards* are independent organizations that establish high-level rules and requirements to ensure the rigor of any credits issued. Examples of standards are the Verified Carbon Standard, the American Carbon Registry, and the Climate Action Reserve. *Methodologies*, also called *protocols*, are approved by standards and provide specific criteria and procedures for projects. Projects must meet the requirements in a methodology in order to receive carbon credits. Currently, there are three approved or pending methodologies for coastal wetland restoration or creation:

- American Carbon Registry, "Restoration of Degraded Deltaic Wetlands of the Mississippi Delta." Status - approved.
- Verified Carbon Standard, "Methodology for Wetland Creation." Status - in validation.
- Verified Carbon Standard, "Accounting Methods to Determine the Greenhouse Gas Benefits of Tidal Wetland Restoration." .Status - draft in preparation.

In addition to these market-based tools, the wetland science community has developed recent tools/models to help land managers quantify the greenhouse gas values in specific landscape settings. See **References** for more information.

Coastal Ecosystem Management, Restoration and Conservation Activities with Potential Climate Mitigation Benefits

Net climate mitigation benefits of projects are determined by comparing the changes in GHG reductions and emissions as a result of the project to the GHG reductions and emissions which would have occurred in the absence of the project (called the '*baseline*').

Conservation of Intact Wetlands: Because wetland soils are significant carbon stores, preventing wetland drainage and degradation, such as through development or conversion to agriculture or aquaculture, can prevent large emissions of CO_2. In the U.S., European Union and Australia, wetland regulations generally prevent large-scale impacts to wetlands, but globally wetland conversion is common. Conserving remaining tidal wetland resources is of critical importance. Eligible management activities are those which conserve carbon stocks within at-risk wetlands through regulation and/or land owner agreements.

Rewetting of Drained Organic Soils: Drained organic soils continue to emit CO_2 until either the water table rises to near the surface of the soil or the stock of carbon is depleted. Management of water tables to reduce CO_2 from drained organic soils is an eligible climate change mitigation activity.

Restoration and Creation of Vegetated Wetlands: A range of wetland restoration and creation activities can provide net GHG benefits. Both restoration and creation seek to restore the combination of native plants, hydrology, and sediment that leads to a self-sustaining productive wetland. Some examples are:

- Lowering of water levels on impounded former wetlands
- Removing tidal barriers
- Rewetting of drained wetlands (for restoration purposes)
- Raising soil surfaces with dredged material
- Increasing sediment supply by removing dikes or levees
- Restoring salinity conditions
- Improving water quality, e.g. for seagrasses
- Revegetation
- Combinations of the above.

Capturing the Blue Carbon Values of Coastal Habitat: Options for Land Managers

1. **Carbon finance**

   The issuance and sale of carbon credits generated by wetland habitat restoration or conservation may be an attractive financing option for some projects. The costs of GHG monitoring, reporting, and verification must be weighed against the potential value of carbon credits. In many cases, additional project funding sources will be required. For example, carbon finance might be used to pay for the long-term maintenance and management of a restored area, an aspect of projects typically under-funded, as a cost share for funds providing for project development.

2. **Improved land management**

   Improved practices for the management of wetland and organic soils can reduce the emissions of GHGs with or without carbon financing. The GHG accounting costs of monitoring, reporting and verification for many smaller projects may negate the opportunity for carbon financing, although the benefits of improved management may be realized as part of a local or regional climate change mitigation strategy.

3. **Stimulate new projects**

   Coastal wetland habitat restoration projects provide numerous ecological and economic benefits. These are fairly well documented in many regions, and at the national level. Two recent reports emphasize the jobs benefits of restoration and the benefits to healthy fisheries (see below). Further work is needed to document the climate mitigation benefits of wetland restoration. The imperative of mitigating for climate change could lead to the prioritization of projects that provide climate mitigation benefits, if such policies are adopted.

4. **Improved policies**

   Adjustment to existing policies that support GHG management of wetland or organic soils, support research, or redirect financing from subsidies for practices that increase emissions to those that reduce emissions could benefit regional and/or national climate change mitigation actions. Requiring consideration of net GHG impacts of a proposed development during review (much like impact on endangered species or even traffic impacts must be taken into account) could result in reduced emissions.

5. **Improved perceptions**

   Publicizing the GHG values of tidal wetlands could improve public perception about the value of tidal wetland restoration and conservation, especially if put into the context of additional ecosystem service benefits. Resource managers, project proponents, funding agencies, and others are encouraged to communicate the GHG benefits of wetland activities at the project, landscape, and/or estuary scale.

Assessing Options - Key Considerations for Carbon Offsets Projects

1. **Economies of Scale**
   The costs of carbon accounting can be significant, both in advance of the project and during project implementation. Some of these costs are fixed, irrespective of the size of the project. For comparison, forest carbon offset projects are often many thousands of hectares in size. Opportunities for wetland restoration at that scale are few, but the carbon benefits may be greater on a per acre basis. Economies of scale accompany large-scale projects; for example reduced implementation costs, and reduced costs of GHG monitoring, reporting, and verification. Several smaller projects, in an estuary or sub-estuary where conditions are similar, may be aggregated to reduce per-project costs.

2. **Avoided Emissions**
   In many degraded wetlands, a restoration project may reduce CO_2, CH_4, and/or N_2O emissions. Similarly, preventing ongoing emissions from wetland soils is also eligible for carbon crediting. Projects which result in avoided emissions will likely result in much greater GHG benefits.

3. **Bundling Other Payments for Ecosystem Services**
   Projects which are required by law are not eligible to receive carbon offsets; this is called the “regulatory surplus test” by carbon standards. However, voluntary wetland projects might generate benefits that others are willing to pay for, and these funds can be additive to carbon credits. It is important that the project proponent develop a financial plan that includes GHG monitoring and accounting costs, as well as project implementation and long-term maintenance. Public grants, private funds, and payments for other ecosystem services can contribute.

4. **Low Project Complexity/Low Risk**
   Wetlands are complex systems and wetland restoration actions may influence the three primary GHGs. Project activities with fewer variables influencing GHG emissions and reductions will lead to reduced transaction and monitoring costs. Low risk projects, such as those in settings with high capacity to respond to sea level rise, will be more likely to generate the anticipated GHG benefits and will be more attractive to potential project investors.

5. **Improved Adaptation**
   Tidal wetland projects take place in a dynamic coastal setting, and sea level rise is accelerating. Restoration projects should take into account sea level rise projections, sediment supply over time, hydrologic inputs, and other factors to ensure sustainability. Projects seeking carbon credits must be designed and managed for a100-year duration. Incorporating response to sea level rise into project design is required. Planning for landscape change with space for wetland migration over time is an important consideration.

6. **Practicability**
   Tidal wetland projects can be complex and take several years from design to implementation and monitoring. Carbon offset requirements add additional complexities and require a multi-decadal commitment. Ideally, developing the carbon accounting aspects of a project will happen in synch with wetland project design. Carbon credits for a project are not issued until after mitigation benefits have been demonstrated, which may be five or more years after implementation. Because significant GHG benefits of a project might not accrue for several years after project completion, the anticipated credits must be weighed against the costs of monitoring, reporting, and verifying credits, and other project costs. Project proponents should develop a realistic project timeline and budget which takes these factors into account.

Developing Projects

Project-level feasibility assessment

If a project is being considered for the carbon market, a feasibility assessment can determine its suitability and its anticipated GHG benefits. A feasibility assessment should include, at a minimum:

- Technical feasibility, including an assessment of the best restoration 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 transcational structures.

Resources

- Restore America's Estuaries - www.estuaries.org
- ESA - http://www.esassoc.com/services/sustainability-and-climate-change
- The Coastal Blue Carbon Initiative - http://thebluecarboninitiative.org/
- Blue Carbon Portal - http://bluecarbonportal.org/
- Verified Carbon Standard - www.v-c-s.org
- Ecosystem Marketplace - http://www.ecosystemmarketplace.com/
- Marsh Equilibrium Model MEM 3.4 - http://ww2.biol.sc.edu/~morris/index.html

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