Chapter 6
The Blue Economy: Mitigation and Adaptation

While the science of developing an adequate database for carbon capture and storage in coastal ecosystems has progressed, the application of this data for actual blue carbon projects and the practical running of a blue carbon project for mitigation and adaptation have also progressed, although not without problems; the truth is that most projects have had low success rates (see Sect. 6.2.1). The scientific literature is still divorced from the management literature reflecting the fact that under most circumstances, research and management discussions are held separately. Thomas (2014) noted in an analysis of the blue carbon literature that scientific concepts of mutual relevance cluster together but that user-defined concepts of business, enterprise, finance, funding and costs tend to appear as outliers, with only a single thread linking them to the concept of blue carbon. In other words, the scientific literature of blue carbon is distinct from the management and economic literature. It seems that science and management of blue carbon are nearly mutually exclusive, reflecting the fact that scientists and managers (and business people) are not interacting with regard to blue carbon. Scientists are viewing blue carbon as a science problem and leaving it to managers to apply the science.

These problems have not stopped the push to incorporate blue carbon into what is now called the 'blue economy'. Spaulding (2016) summarises what is driving the new blue economy: a push to adapt the UN Sustainable Development Goals (**SDG**) for the global ocean, especially Goal 14 'Conserve and sustainability use: the oceans, seas and marine resources for sustainable development'. This goal reflects an upgrade on the traditional ocean economy of offshore oil and gas, recreation and commercial fishing, aquaculture, shipping, coastal tourism and telecommunications into renewable energies, remediation/restoration, seabed mining and blue biotechnologies. The new blue economy is thus an upgrade from destructive extraction-focused businesses to sustainable, clean technologies, including blue carbon. The new blue economy is to promote economic benefits of 'good for the ocean' industries and activities while ensuring truly sustainable development. The problem is how to classify these different industries under one umbrella to ensure a level of stewardship, good environmental and social practices and the use of the

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precautionary principle in industry to minimise the chance of unsustainable development or industrial accidents or perverse outcomes. Again, the problem remains how to incorporate science into the new blue economy given the reluctance of scientists and managers to cooperate.

This problem is one of several that we will explore in this chapter. Needless to say, it is not uncommon in this author's opinion for scientists and managers to speak different languages and to operate separately. Rare is the environmental problem where scientists and managers work closely together to foster the best outcome. Such linkage is and will remain crucial for successful blue carbon projects.

6.1 Ecological Economics

The 'tragedy of the commons' principle stresses that in a situation within a shared resource system, individual users acting independently (according to their own self-interest) will behave contrary to the common good of all users by depleting that resource through collective action. Wilkinson and Salvat (2012) have asserted that this concept applies to coral reefs, mangrove forests and seagrass beds in the tropics, accounting from much of the degradation of coastal resources. Despite scientific advances in our knowledge of such ecosystems and considerable conservation and management effort, they continue to decline. In the tropics, much of this decline in coastal resources is due to increasing exploitation driven by poverty and progress; in the rest of the world, pollution and so-called economic progress have resulted in a concomitant decline in salt marshes and kelp forests. Thus, the global decline in coastal resources has continued unabated making mitigation and adaptation projects and education a higher priority more than ever. Wilkinson and Salvat (2012) concluded that the solution to the problem will be implementing exceedingly difficult and controversial moral decisions.

With blue carbon, such decisions will need to be made at the national level, but the reality is that humans preserve best what is most financially and culturally valuable to them. The concept of a blue carbon project is economically viable; the high cost/benefit ratios for loss versus conservation of coastal ecosystems are high, with economic damage resulting from conversion currently amounting to between $6 to $42 billion US per year (Pendleton et al. 2012; Thomas 2014). Planning and investment decisions are based on direct financial benefits rather than broader environmental or economic concerns. A good example is shrimp farming where mangrove deforestation is a product of coastal aquaculture. Incomes from this industry range from $700 US per hectare to as much as $36,000 US per hectare with an average of about $6000 US. This is crucial because, in theory, ecosystem protection may be viable at moderate carbon prices to yield positive mitigation and adaptation outcomes; net economic returns on investment may be possible for as little as $15 to $20 US per hectare (Murray et al. 2011; Siikamäki et al. 2012). In practical terms, what this means is that to replace this income from farming, carbon payments would need to be at least $3.14 US per Mg CO_2 equivalents for low-profit farmers, $27 US for the average farmer and $156 US for high-income farmers (Yee 2010). The implication for blue carbon is that for a farmer to invest in conservation of resources rather than to continue farming, this option must have greater financial potential.

6.1.1 Payment for Ecosystem Services (PES)

Another one of the problems associated with blue carbon science and management is having a proper understanding of the actual cost of an ecosystem service, which is a tangible good or intangible function that benefits people. As pointed out by Lau (2013), coastal ecosystems simultaneously provide a number of services in addition to the potential for carbon storage. For instance, a mangrove forest or salt marsh may provide food, fuel, natural products, shoreline stabilisation, natural hazard protection, nutrient regulation (e.g. from storms, cyclones and floods), waste processing as well as supporting cultural services such as tourism, recreation, education spiritual values and aesthetics. In reality, these different services are all interconnected as well as interlinked to adjacent coastal ecosystems. A salt marsh, for instance, can provide some degree of protection from storm surges while also sequestering carbon and providing food (e.g. fish and shellfish) to locals as well as serving as a nursery ground for commercially valuable fisheries. Mangroves and seagrass meadows perform identical multiple functions that cannot be easily separated from one another. Further, their ability to perform such functions may depend upon the health of their own system, but also adjacent habitat, thus having cascading effects across ecosystems in the coastal zone.

With this service concept, ecosystem functions can be costed in terms of their ability to assist human well-being. For example, in 2003, coral reefs were estimated to provide $29.8 US billion annually in net benefits to humanity (Cesar et al. 2003). Tourism and recreation account for 32% of this value, coastal protection accounts for 30%, while fisheries and biodiversity account for 19%. Similarly, the World Resources Institute’s Reefs-at-Risk programme estimates that the shoreline protection value of coral reefs and mangroves in Belize alone amounts to $231–$347 US million (Cooper et al. 2009), which approximates 9–14% of the nation’s gross domestic product.

In Colombia, carbon sequestration benefits have been modelled into an economic system that has valued both mangrove and seagrasses within a new network of marine protected areas (Zarate-Barrera and Maldonado 2015). The model considers the capacity of mangroves and seagrasses for capturing and storing blue carbon and simulates scenarios for the variation of key variables, such as the market carbon price, the discount rate, the natural state of loss of these ecosystems and the expectations about the post-Kyoto agreements. The results of the model show that the expected benefits of blue carbon storage are substantial, but highly dependent on post-Kyoto negotiations and the dynamics of the carbon credit’s demand and supply; natural loss rate of these ecosystems had no significant effect on the annual value of carbon stored. More importantly, under this scheme, the annual rates of carbon capture would increase from 49 to 94%, and total carbon storage would increase from 49 to 68% with respect to current protection areas.

A cost-benefit study has been done for mangrove plantations in northern Bohol in the Philippines to estimate the benefits, if any, of a ‘win-win’ scenario to mitigate climate change. Carandang et al. (2013) used three carbon prices in the international market to determine the net incremental benefits at different ages of mangrove plantations as well as net present values (**NPVs**) and prices of these plantations. They found that at the lowest price of $10 US per tonne the NPV is negative with it starting to become positive at a carbon price of $15US per tonne at year 20 up to year 50 with the corresponding computed NPV would be $167.16 US at year 20 and $467.14 US at age 50. All NPVs are positive once the carbon price reaches $20US per tonne. Therefore, establishing a carbon market for mangrove plantations is feasible, but very sensitive to the international carbon price. The additional problem would be the number of years of growth required to sustain mangrove carbon biomass during which time there is no guarantee what the carbon price on the international market will be.

While seagrass plantations do not yet exist, the sensitivity of payments for ecosystem services to carbon prices would also be an issue. Dewsbury et al. (2016) reviewed the prospects for further inclusion of seagrasses in climate policy frameworks as well as the potential for developing payment for ecosystem service (**PES**) schemes that are compatible with carbon management. They found that the prospects are slim, especially if targeted at the regulatory carbon market. This conclusion was reached mainly because of the doubts about the costs and financial markets and their relative instability. Voluntary carbon market schemes may be more promising, but these too are instable making a purely carbon market-based approach questionable, meaning that fluctuating carbon prices would impose excessive risk for a viable return on investment. Like mangroves and salt marshes, seagrass plantations or seagrass conserved areas would require a significant investment in time during which the international carbon price may fluctuate. What may seem as a solid investment at the start of a project may not be so solid several years later.

Some services (e.g. fisheries) are easier to estimate than others, and some are virtually impossible to estimate (e.g. cultural values). The problem is that there is no adequate ‘one-size-fits-all’ policy to determine the valuation of ecosystem services. As Lau (2013) points out, there are new policy tools and management mechanisms to correct for undervaluation and market failures, but at this stage, there is not even one overarching definition of payment for ecosystem services (**PES**).

Currently the valuation for PES is captured mostly for provisioning services such as fisheries while there is still a large gap in capturing the value of regulating, supporting and cultural services. Nevertheless, Lau (2013) has offered a framework for developing a PES scheme for blue carbon. First, clear identification of the ecosystem service in question (carbon sequestration) as well as the habitats where it is found and the biological and physical attributes contributing to provisioning of the ecosystem service is required. Second, the range of stakeholders who might be directly involved in the scheme should be identified. Third, the availability and suitability of performance indicators for baseline assessment and monitoring, the measurement of uncertainty and the management activities for achieving desired results need to be determined. For instance, the tonnes of CO_2 sequestered or in emissions avoided or carbon sequestration rates, the uncertainty of the methodologies used and proxy management activities such as prevention or reduction in deforestation/degradation are all issues that need to be considered in any PES scheme.

Few studies have estimated a monetary value for PES as it is difficult to so do for the reasons just discussed. However, Estrada et al. (2015) determined the value of mangrove carbon storage in south-eastern Brazil considering pre-existing estimates of carbon storage in the above-ground biomass and average transaction values of carbon credits. The mean monetary values ranged from \$19.00 US ha^{-1} $year^{-1}$ for high intertidal basin forests to \$82.28 US ha^{-1} $year^{-1}$for low intertidal fringe forests. They estimated that the service of carbon sequestration may be worth up to \$455,827 US $year^{-1}$ while carbon stored is worth \$3,477,041 US across all mangrove forests and values between \$104,311 and \$208,622 US ha^{-1} $year^{-1}$ can be considered as the annual maintenance costs of this service.

The use of PES for coastal conservation via blue carbon appears feasible despite shortcomings. More research is required to elucidate the best practices to overcome these difficulties. For instance, more science and economics connecting specific management activities to produce a quantifiable outcome are necessary, as well as metrics and performance indicators to assess baselines and measure service delivery are required.

Also, new institutional frameworks will be required to manage payments and verify service delivery; education and capacity building will be required given the newness of such PES schemes. Payment for carbon credits is a clear outcome that can basically follow terrestrial PES schemes in including other ecosystem services (or at a minimum not excluding them). For example, managing a salt marsh to maximise carbon sequestration may not necessarily maximise the other ecosystem services. Perverse outcomes must thus be minimised. The key will be to identify those situations for which 'payments will be effective, cost-efficient, equitable and culturally acceptable, and those for which payments are not' (Lau 2013).

6.1.2 Regulatory and Policy Matters

Existing voluntary and regulated carbon markets are not equipped to address the complexities of social/ecological systems, for example, the problem of land tenure and traditional ownership. Markets do not recognise non-financial social and environmental benefits that might result in ecosystem-based carbon management. Projects are unlikely to proceed without providing goods and ecosystem services due to technical, institutional, administrative and financial constraints. Stakeholder engagement is required as blue carbon projects need to be commercially attractive propositions.

Insurance markets may be a way to finance or insure carbon products, that is, carbon stores are well-recognised as a market-based commodity. Certainly, governments and land owners have some incentive to insure their investment although there are constraints on the insurance pathway: lack of regulatory requirements, the absence of commercial incentives and resources, and physical practicalities (Thomas 2014). Thomas (2014) suggested that property insurance may be applied to blue carbon projects as carbon values and the wetlands themselves are already recognised in existing market-based instruments. A risk management approach involving a regulated or voluntary insurance instrument could be used to support a functional market for blue carbon.

The problem of time is a significant qualifier in any means to incorporate blue carbon projects into carbon markets. Plants take time to grow, and unlike commercial projects such as wheat, corn, barley, rice and rye, salt marsh grasses and seagrasses cannot be used as a commercial carbon product as nearly all of their carbon is stored in soils which take time to sequester significant and marketable amounts of carbon. Duarte et al. (2013a, b) recently examined the long-term potential of carbon sequestration in a seagrass restoration project by developing a model that combined models of patch growth, patch survival in seagrass planting projects and estimates of seagrass CO_2 sequestration per unit area for five seagrass species commonly used in restoration projects. They found that the cumulative carbon sequestered increased rapidly over time and planting density plateaued at 100 plants ha^{-1}. At this planting density, the modelled cumulative C sequestered ranges from 177 to over 1337 Mg CO_2 ha^{-1} over 50 years. The model thus suggests that the costs of seagrass restoration programmes may be fully recovered by the total CO_2 captured if there was a carbon tax in place in the given locale. Seagrass restoration programmes are therefore economically viable strategies to mitigate climate change through carbon sequestration.

The International Blue Carbon Policy Working Group has developed a blue carbon policy framework (Herr et al. 2012). Such a policy is timely as scientific understanding of wetland carbon capture and storage is sufficient to warrant development of effective policy, management and conservation incentives for coastal blue carbon. The development and implementation of blue carbon projects requires a policy framework that can deal with the management, conservation and financial issues arising from such a project. The policy framework was designed to:

- ‘Define activities and a timeline to increase policy development, coastal planning and management activities that support and promote avoided degradation, conservation, restoration and sustainable use of coastal blue carbon systems;
- Define actions and a timeline to develop and implement financial and other incentives for climate change mitigation through conservation, restoration and sustainable use of coastal blue carbon;
- Identify key stakeholders, partners and blue carbon champions to implement the identified policy actions and define materials and products needed to support such activities; and

Table 6.1 Summary of the blue carbon policy framework

1. *Integrate blue carbon activities fully into the international policy and financing processes of the UNFCCC as part of mechanisms for climate change mitigation*
'Ensure recognition and inclusion of blue carbon sinks and sources into the outcome of the Durban Platform'
'Build awareness in the climate change policy community of the strength of scientific evidence of the carbon sequestered and stored in coastal ecosystems and of the emissions resulting from the degradation and destruction of these systems'
'Enhance the scientific and technical basis (data, reporting and accounting guidelines, methodologies, etc.) for financing of coastal carbon management activities'
'Access carbon finance through UNFCCC mechanisms and related funding streams'
'Include blue carbon management activities as incentives for climate change mitigation by Annex-I Parties'
'Monitor discussions on agriculture and its relevance for blue carbon'
'Support capacity-building activities to implement blue carbon management activities'
2. *Integrate blue carbon activities fully into other carbon finance mechanisms such as the voluntary carbon market as a mechanism for climate change mitigation*
3. *Develop a network of demonstration projects*
'Develop a strategic approach for the coordination and funding of demonstration projects'
'Provide capacity building at local and national level'
4. *Integrate blue carbon activities into other international, regional and national frameworks and policies, including coastal and marine frameworks and policies*
'Enhance implementation and inform financing processes of relevant Multilateral Environmental Agreements (**MEAs**) that provide policy frameworks relevant for coastal and marine ecosystem management'
'Use existing international frameworks to advance and disseminate technical knowledge on coastal ecosystems management for climate change mitigation'
'Use existing international frameworks to raise awareness of role of conservation, restoration and sustainable use of coastal ecosystems for climate change mitigation'
'Integrate coastal ecosystem conservation, sustainable use and restoration activities as a mechanism for climate change mitigation into relevant regional policy frameworks'
'Integrate coastal ecosystem conservation, sustainable use and restoration activities as a mechanism for climate change mitigation into existing national, subnational and sectoral policy framework'
5. *Facilitate the inclusion of the carbon value of coastal ecosystems in the accounting of ecosystem services*

From Herr et al. (2012)

- Identify opportunities, limits and risks of advancing blue carbon in different international climate, coastal and ocean policy fora'.

Table 6.1 summarises the five basic precepts for a policy framework on integrating blue carbon into the UNFCCC and other international and financing processes and markets. It also recommends a series of demonstration projects to begin the process of actually running a blue carbon project and bringing it to fruition. Blue carbon science and management need to be incorporated into international, regional and national frameworks that already exist to support climate change mitigation utilising coastal ecosystems, namely, wetlands such as salt marshes, mangrove forests and seagrass meadows.

The UNFCCC is the main mechanism by which blue carbon will be included into international frameworks. The UNFCCC in Article 4(d) calls for parties to 'promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including [......] oceans [......] as well as [......] other coastal and marine ecosystems'. As pointed out by Herr et al. (2012), coastal ecosystems have been largely excluded from UNFCCC-related mechanisms despite Article 4(d). However, a number of other mechanisms exist that currently support emission reductions and removals from natural systems under the UNFCCC: **REDD+** (Reducing Emissions from Deforestation and Forest Degradation), **NAMAs** (Nationally Appropriate Mitigation Actions) and **LULUCF** (Land-Use and some Land-Use Change and Forestry) including those implemented under **CDM** (Clean Development Mechanism). Blue carbon may therefore be included in these activities.

Outcomes from the new Durban Platform (a working group has been agreed under the 2011 UNFCCC COP17 meeting in Durban to address a variety of topics on mitigation, adaptation, finance, technology development and transfer, transparency of action and support and capacity building) have incorporated the contribution of natural carbon sinks and reservoirs to climate change mitigation and thus may include blue carbon activities.

Unfortunately, the climate change policy community is largely unaware of blue carbon research to date (Herr et al. 2012), so it is urgent that the level of awareness be highlighted to include the magnitude and strength of the ability of salt marshes, mangroves and seagrasses to sequester and store carbon and the danger of the continuing decline of the wetlands for GHG emissions.

Recently, the 2013 IPCC Guidelines for National GHG Inventories was completed with a chapter on coastal wetlands (Kennedy et al. 2014). This chapter has established data, reporting and accounting guidelines and levels of methods required to estimate national inventories of GHG emissions from salt marshes, mangrove forests and seagrass meadows. This chapter thus enhances the scientific and technical basis for financing of coastal carbon management activities.

To access carbon finance through UNFCCC mechanisms and related funding streams, Herr et al. (2012) recommend that (1) mangroves be incorporated into REDD+ activities as for terrestrial forests, (2) NAMAs be developed for coastal carbon ecosystems and (3) improved management of blue carbon coastal systems through climate change adaptation financing be supported. Capacity building also needs to be supported as it is essential for developing nations to have the ability to conduct and manage their own blue carbon projects. It has also been pointed out that other carbon finance mechanisms can be used to fund blue carbon projects, such as current organisations like the Verified Carbon Standard (**VCS**) or the American Climate Registry (**ACR**) which are used by carbon mitigation projects to verify and issue carbon credits for the international voluntary offset market.

A network of demonstration projects is needed to show the viability of blue carbon and to work out in a practical way the problems and pitfalls of running a project. Demonstration projects will provide a venue for testing methodologies and for testing tools for the UNFCCC and other frameworks that support carbon accounting. Capacity building is also a good reason for demonstration projects as they are essentially a teaching tool for national abilities to work and run a project. The most challenging problem for demonstration projects is getting the initial funding.

Blue carbon needs to be integrated into international, regional and national frameworks and policies, and there are a number of policy frameworks that already make reference to conservation, sustainable use and restoration of, and reduced emissions from, coastal ecosystems: the Convention on Biological Diversity (**CBD**), Ramsar Convention on Wetlands (**RAMSAR**), UN Conference on Sustainable Development (Rio +20), UN Open-ended Informal Consultative Process on Oceans and the Law of the Sea and UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (**GPA-Marine**). Meetings and communications associated with policy frameworks will provide an opportunity for building awareness and support for coastal blue carbon.

Blue carbon as a vehicle for conservation, sustainable use and restoration also needs to be fully integrated into existing national and regional policy frameworks as a mechanism for climate change mitigation. This may be time-consuming and difficult as only some developing nations have a national or a series of subregional policies on blue carbon or coastal ecosystem use in climate change mitigation. Perhaps the best way to accomplish integration is to communicate the strength of the coastal carbon sinks and how wetlands link closely into existing frameworks on policies for watersheds, including agriculture and flood control. Another pathway to integration is the insurance industry, which already recognises the value of coastal habitats in protection against storm damage, sea-level rise and flooding risk. Integration may also be forthcoming in the aquaculture industry when the emissions from aquaculture are offset by the savings from conserving remaining habitat; we have seen in earlier chapters how great GHG emissions are as a result of habitat destruction. This pathway may also take advantage of stacking and bundling of ecosystem services as, for example, remaining mangrove forests in close proximity to a shrimp farm may still retain a nursery function and other functions such as shoreline protection, water clarity and a source of biodiversity.

These later functions are well-established for blue carbon wetlands, but vulnerability assessments are still needed involving basic science parameters of the ecosystem as well as local community knowledge. There is also the need to highlight the critical role of social factors in vulnerability assessment and development planning as well as the need to incorporate other ecosystem services such as maintaining biodiversity and storm protection. However, one of the main problems with vulnerability assessments traditionally is that they tend to focus solely on sea-level rise without considering other aspects of climate change. Osland et al. (2016) make the argument that macroclimatic drivers (temperature, rainfall) need to be considered in vulnerability assessments as they are for terrestrial ecosystems. They show how even small changes in macroclimatic conditions can foster large changes in wetland ecosystem structure and function.

6.2 Restoration and Management

A number of blue carbon projects have been and are currently operating, mostly recently as demonstration projects involving the rehabilitation and restoration of mangrove forests (Table 6.2). Most are capacity-building exercises and financed from research or public development institutions; few are private sector projects through generation of carbon offsets for the voluntary/regulated carbon market. No project as yet has sold carbon offsets to market illustrating that at this point in time blue carbon is either not yet a viable market commodity or communication with private investors is lacking. It is also true to say that blue carbon is still a new initiative and it will take some time to generate private investment until these demonstrations projects provide ‘proof of concept’. Wylie et al. (2016) describe the tools necessary to make a successful blue carbon project by examining case studies; there are benefits in (1) incorporating livelihood aspects as part of the project and (2) involving members of the local community in all stages of planning and implementation. The importance of involving local communities is common sense as a project cannot succeed in isolation. Community involvement ensures that ‘leakage’ does not occur, that is, protection in one place does not lead to destruction someplace else. Blue carbon projects may not be able to overcome the threats that will likely occur due to local use of, for example, mangroves unless the local community sees benefit such as opportunities for income. Wylie et al. (2016) argue that there is much benefit in small, community-based projects in financing via the voluntary carbon market as the requirements are less stringent than financing via UNFCCC mechanisms.

The reader is referred to the following websites for updates on current and future projects: thebluecarbonproject.com, thebluecarboninitiative.org and blucarbonportal.org.

6.2.1 Success or Failure: What Does and Doesn’t Work

The current projects are small-scale and focused on science or economics with little if any merging of the two, and it will take some time to fully integrate them into the conservation and management sphere, at least not until they achieve ‘proof of concept’ successfully. In fact, a perusal of the literature indicates that most restoration and rehabilitation projects, especially of salt marshes and seagrass beds, have failed to meet success criteria. Landscape setting, habitat type, hydrological regime,

Table 6.2 Some blue carbon projects past and present around the globe

Location	System	Activity	Proponents	Project type	Financial return	Other outputs
Brazil	S	DC	Instituto de Oceanografia-Federal University of Rio Grande	R	None	Biophysical data including carbon dynamics
Brazil	S	DC	Universidade Estadual de Rio de Janeiro; Universidade Federal of Rio Grande; Universidade Federal de Santa Catariana e Universidade Federal Rural de Pernambuco	R	None	Biophysical data including inferred carbon stocks
Brazil	SM, S, M	DC	Institute of Oceanography-University of Sao Paulo with collaboration of 39 Brazilian institutions	R	None	Biophysical data including inferred carbon stocks
China	M	DC	Tsinghua University; Xiamen University	R	None	C sequestration and flux baseline data; social and demographic data
Tanzania	M	DC	WWF; Sokoine University of Agriculture; University of Dar es Salaam; Lawyers Environmental Action Team; Journalists Environment Team	R	None	C sequestration and flux baseline data; REDD+ policy integration
USA	SM	R	University of Maryland; US Fish and Wildlife Service	R	None	C sequestration and flux baseline data
	M	R, AE		PES	None	

(continued)

Table 6.2 (continued)

Location	System	Activity	Proponents	Project type	Financial return	Other outputs
Democratic Republic of the Congo, Cameroon			UNEP; Cameroon Wildlife Conservation Society; UNEP-World Conservation Monitoring Centre; Kenya Marine and Fisheries Research Institute			C sequestration and flux baseline data; REDD+ policy integration
Madagascar	M	R, AE	Blue Ventures	PES	None	C sequestration and flux baseline data; REDD+ policy integration
Gambia, Guinea and Guinea-Bissau	M	R, AE	UNEP, Canary Current Large Marine Ecosystem; Wetlands International; IUCN	PES	None	Biophysical data including carbon dynamics
Indonesia	M	R	Wetlands International; The Nature Conservancy; Deltares; Wageningen University; various Indonesian partner organisations	PES	None	Research and publication of 'Mangrove Capital' to guide planning and development
Costa Rica	M	DC	Tropical Agricultural Research and Higher Education Center; BIOMARC Project; Universidad Nacional de Costa Rica	PES	None	C sequestration and flux baseline data; community participation and capacity building
Abu Dhabi, UAE	M	DC	Abu Dhabi Global Environmental Data Initiative (AGEDI)	BC	None	C sequestration and flux baseline data; REDD+ policy integration

(continued)

Table 6.2 (continued)

Location	System	Activity	Proponents	Project type	Financial return	Other outputs
Philippines	M, S	DC	Science & Technology Research Partnership for Sustainable Development; JICA-JST; Tokyo Institute of Technology	BC	None	C sequestration and flux baseline data; REDD+ policy integration
USA	SM	AE	Waquoit Bay National Estuarine Research Reserve; NOAA; National Estuarine Reserve Research System Science Collaborative	BC	None	C sequestration and flux baseline data; carbon stock assessment tool
Vietnam	M	AE	SNV Netherlands, IUCN, International Climate Initiative, German Federal Ministry for the Environment, Building and Nuclear Safety (BMU), Minh Phu Liveihoods, Danone Fund for Nature	BC	Premium market price from shrimp while conserving mangroves	Financing from Naturland Organic Shrimp Certification
Panama	M	AE	UNDP; Panama Environment Authority; Panama Aquatic Resources Authority; The Nature Conservancy; Wetlands International	BC	None	C sequestration and flux baseline data; REDD+ policy integration

(continued)

Table 6.2 (continued)

Location	System	Activity	Proponents	Project type	Financial return	Other outputs
Kenya	M	R, AE	Napier University; Kenya Marine Fisheries Institute; Earthwatch Institute	BC	Expected to generate 2.5 kt CO_2e/year or $12,000 for 20 years	Registered small-scale Plan Vivo (voluntary scheme) restoration project (see technical details at Plan Vivo Foundation website
Senegal	M	R	Livelihoods Fund; L'Oceanium de Dakar	BC	Expected to generate 2.7 kt CO_2e/year for 30 years	Registered CDM small-scale reforestation project (see cdm.unfccc.int project ref#5265)
Mozambique	M	AE	WWF; US Forest Service; USAID; University of Eduardo Mondlane; Kenya Marine and Fisheries Research Institute	BC	None	Biophysical data including carbon dynamics
Ghana	M	R	Coastal Resources Center	BC	None	C sequestration and flux baseline data; REDD+ policy integration
India	M	R	Livelihoods Fund	BC	Expected to generate 8 kt CO_2e/year for 20 years	CDM small-scale afforestation/reforestation project (see cdm.unfccc.int) in the Sundarbans
China	S, M, SM	DC	Tsinghua University; Xiamen University; State Oceanic Administration	BC	None	C sequestration and flux baseline data
Indonesia	M	R	Ministry of Forestry of Batam City; Y.L. Invest Co; Team Permanent Mangrove	BC	Expected to generate 3.8 kt CO_2e/year for 30 years	CDM small-scale afforestation/reforestation project (see cdm.unfccc.int)

(continued)

Table 6.2 (continued)

Location	System	Activity	Proponents	Project type	Financial return	Other outputs
Indonesia	M	R	Livelihoods Fund; Yagasu Aceh	BC	Expected to generate 105 kt CO_2e/year for 20 years	VCS reforestation project
Indonesia	S, M	R, AE	Agency for Research & Development of Marine & Fisheries; Ministry of Marine Affairs; Fisheries Indonesia	BC	None	C sequestration and flux baseline data; REDD+ policy integration
Indonesia	M	R, AE	Charles Darwin University; Japesda; Yayasan Hutan Biru	BC	None	Ecological restoration; community development
Indonesia	M	R	Wetlands International	BC	None to date	Community-based microcredit programme to improve shrimp farming through mangrove restoration with carbon credits produced

Updated from Thomas (2014)
Abbreviations: *SM* salt marsh, *S* seagrass, *M* mangrove, *RST* restoration, *DC* data collection, *AE* avoided emissions, *R* research, *PES* payment for ecosystem services, *BC* blue carbon

soil properties, invasive species, disturbance regimes, seed banks and declining biodiversity among a host of factors can constrain the restoration process (Zedler 2000).

There is a problem in that most restoration and rehabilitation projects have suffered from poor management protocols such as not having proper success or failure criteria and have suffered from poor or uncertain methodology. There are few if any clear guidelines for restoration of seagrasses (van Katwijk et al. 2009), mangroves (Field 1998; Ellison 2000; Wylie et al. 2016) and salt marshes (Williams and Faber 2001). The experiences of salt marsh restoration in San Francisco Bay (Williams and Faber 2001) indicate several important issues learned that are also applicable for mangrove and seagrass restoration:

- 'Habitats can be restored if the correct sites have been chosen;
- Methodology of restoration is still experimental as it is not known what percentage of the original ecosystem function returns nor how long it takes;
- Successful restoration is greatly dependent on restoration of hydrodynamic processes;
- Restoration projects must have clear statements of measurable, achievable biological objectives including success and failure attributes;
- Restored habitats are best viewed as immature ecosystems that will mature with time;
- Natural evolution of ecological processes of a restored habitat may take a long period of time;
- Monitoring of restoration is mandatory in order to determine the success or failure of the project including the amount of carbon sequestered;
- Planning and management of physical processes should preferably be on the conservative side to allow for habitat development'.

For mangrove ecosystems, Lewis (2005) reviewed the existing information as well as his own practical work and concluded that assessing the existing hydrology of natural habitats and then applying this information to a habitat to be restored is of prime importance. His restoration principles:

1. 'Get the hydrology right first;
2. Find out why a given site has lost its mangroves or why the given site has never had mangroves;
3. Once you find out why, see if you can correct the conditions that currently prevents natural colonization of the selected mangrove restoration site. If you cannot correct these conditions, pick another site;
4. Use a reference mangrove site for examining normal hydrology for mangroves in your particular area. . .. . . establish the same range of elevations as your reference site at the site to be restored or restore the same hydrology to an impounded mangrove by breaching the dikes in the right places. The "right places" are usually the mouths of historic tidal creeks. These are often visible in. . . .. photographs;
5. Remember that mangrove do not have flat floors. There are subtle topographic changes that control tidal flooding depth, duration and frequency. Understand the normal topography of your reference forest before attempting to restore another area;
6. Construction of tidal creeks within restored mangrove forests facilitates flooding and drainage, and allows for entrée and exit of fish (and other biota and nutrients) with the tide: and
7. Evaluate costs of restoration early in project design to make your project as cost effective as possible'.

These principals are also valid for salt marshes and, with some adaptation, for seagrass beds. The first European Seagrass Restoration Workshop concluded similarly that priority should be given to natural restoration, with emphasis on the fact that 'restoration should never be considered the first alterative when planning for the mitigation of coastal development projects or to justify mitigation as a compensation measure for economic activities' (Cunha et al. 2012). The results show that none of the seagrass restoration projects developed in Europe by the participants during the past 10 years was successful. The group endorsed several recommendations prior to the start of a restoration project:

1. 'Establish clear goals and objectives prior to initiation of restoration;
2. Define monitoring methods and success criteria…… and make accommodations for long-term monitoring (i.e. 5–10 years) a part of the initial project;
3. Include donor population monitoring in the project;
4. Make every effort to ensure that local threats (e.g., bioturbation, herbivory, hydrology, sediment movements, human impact, etc.) to seagrasses are well known……..start only when all threats causing loss have been eliminated;
5. Initiate with small-scale or pilot restoration trials………..;
6. Devices to anchor plants or protect them against storms, sediment dynamics or herbivory should be avoided…..;
7. Covering the transplant rhizomes with a local stone or sand bag to improve the technique seems to be a positive exception…………….provided that sites are carefully selected……;
8. The application of a shell layer is another positive exception as it works to stabilize sediments……;
9. Traditional local knowledge can give a big help…………….spread the trials throughout different sites and use different methods. Learn and be willing to change plans based on the experienced results (adaptive management);
10. Strive to learn from the experience of others and use the information to improve methods at different sites. It seems that it may take more than 5–10 years to start becoming successful;
11. Almost all scientists expressed frustration about natural beds being disturbed and/or natural recovery being prevented (trawling, shellfish/bait collection, tourist activities, etc.). This is partly due to the absence of law enforcement and partly due to limited regulation or protection status or modification of protection status if economics prevail. Make sure you have identified all these constraints and their magnitude and frequency before starting a restoration effort'.

Success criteria for seagrass restoration in many areas focuses on persistence, area restored and shoot density (Fonseca et al. 2000). Van Katwijk et al. (2009) concluded that the success of a seagrass restoration project is dependent on habitat selection and selection of the donor population, spreading of risks and ecosystem engineering efforts. This is also true for salt marshes and mangroves. For example, Arachchilage et al. (2017) found in assessing restoration efforts of mangroves in Sri Lanka that restoration success is highly variable, with success rates varying from 0 to 78%; 9 of 23 project sites showed no surviving plants.

How do we assess the success of a restoration project in terms of blue carbon? Carbon storage as a result of the project can be calculated by measuring the addition of blue carbon in the restored site by measuring the C_{org} content in soils multiplied by some measure of recent sedimentation, for example, by R-SET. Marbá et al. (2015) reconstructed the trajectories of carbon stocks associated with one of the longest monitored seagrass restoration projects. They demonstrated that sediment carbon stocks erode following seagrass loss and that revegetated projects restore seagrass carbon sequestration capacity by combining carbon chronosequences with ^{210}Pb dating of seagrass sediments in a meadow that experienced losses until the end of the 1980s and subsequent serial revegetation efforts. Inventories of excess ^{210}Pb showed that its accumulation and thus sediments coincided with the presence of seagrass vegetation. Seagrass regeneration enhanced carbon deposition and burial with carbon burial rates increasing with the age of restored sites; 18 years after planting, they were similar to that in continuously vegetated beds. Greiner et al. (2013) similarly found that seagrass restoration enhances carbon sequestration. In their study of meadows of different age in Virginia, measurements were made of percent carbon and ^{210}Pb from dating at 1 cm intervals to a depth of 10 cm. They found that carbon accumulation rates were higher in 10-year-old meadows compared with 4-year-old beds and bare sediment.

Can coastal ecosystems be managed to sequester more carbon? Macreadie et al. (2017a; b) discussed three potential management strategies that hold some promise for optimising carbon sequestration:

1. ‘Reducing anthropogenic nutrient inputs;
2. Reinstating top-down control of bioturbator populations; and
3. Restoring hydrology’

The first management strategy is true in that most evidence shows that there is a decrease in carbon storage with nutrient addition. For example, there are usually net losses of carbon either through plant mortality and gaseous efflux or through erosion and loss of sediment. A risk assessment by Lovelock et al. (2017) has shown that there is increased risk of high CO_2 emissions in blue carbon ecosystems with increasing stocks of soil organic carbon. The second strategy is based on evidence that shows that high densities of bioturbators can have negative impacts on soil carbon stocks and fluxes; low to moderate levels of bioturbation help stimulate plant growth, but high levels result in high losses of CO_2. The third strategy involves the reestablishment of tidal exchange which will modulate CO_2 fluxes back to natural rates of emission. Data from ponded systems has shown that conversion of coastal ecosystems through tidal flow restriction can disrupt carbon sequestration by coastal ecosystems and may switch these ecosystems from being net sinks to net sources of carbon (Lovelock et al. 2017).

6.3 Financing

Financing remains a key concern for blue carbon projects to eventuate and proceed successfully. Table 6.3 summarises the range of different funding approaches to blue carbon projects in developing and developed nations with the type of finance and whether or not the carbon benefit flows or remains.

Table 6.3 Features of different funding approaches to blue carbon activities

Activity	Can occur in a developing (D) or developed (DV) country	Finance	Carbon benefit
NAMAs/NAPAs[a]	D	DO, I	R
Climate-related ODA[b]	D	I	R
Bi- and multi-lateral activities[c]	D, DV	DO, I	R
REDD+	D	I	F
National NRM actions[d]	D, DV	DO	R
Voluntary offsets (e.g. VCS)[e]	D, DV	P	R, F
Compliance offsets (e.g. CDM)[f]	D	P	F
Domestic compliance offsets (e.g. CFI, CCERs)[g]	D, DV	P	R
CSR projects[h]	D, DV	P	R
Others (insurance microfinance, green bonds)[i]	D, DV	DO, I, P	R

Modified from Thomas (2014)

Abbreviations: *DO* domestic public finance, *I* International public finance, *P* private, *R* remains, *F* flows

[a]Nationally Appropriate Mitigation Actions (NAMAs) are agreed actions taken by developing countries as part of their commitments under the terms of the UNFCCC. National Adaptation Programmes of Action (NAPAs) are limited to least developed countries

[b]Official development assistance (see www.oecd.org/dac/)

[c]Bi- and multilateral activities refer to agreements made between nations or regional groups of nations or activities implemented through partnerships with public funding institutions such as the World Bank or Asian Development Bank

[d]Natural resource management (NRM) at the national level can occur in a variety of ways depending on local regulatory and social conditions

[e]Voluntary market carbon offsets can be sourced through a variety of providers including Verified Carbon Standard, the American Carbon Registry and others. China has created its own domestic carbon offset

[f]Regulated domestic emissions trading schemes require international carbon offsets to be sourced from benchmark mechanisms, principally the Clean Development Mechanism (CDM) and joint implementation (JI) schemes established by the Kyoto Protocol to the UNFCCC

[g]National carbon reduction compliance schemes continue to be established, and these legislative initiatives usually create their own unique domestic carbon offset units, generally oriented towards eventual integration with international market mechanisms

[h]Corporate social responsibility (CSR) is an important area for potential blue carbon funding that may not be considered in most discussions of climate finance opportunities, because many large organisations may choose to invest in voluntary projects without a carbon focus. Depending on the scale of the activity, this might be a useful consideration for project developers

[i]Climate bonds are a new class of financial asset that can be issued by governments or private institutions and operate in the same manner as standard debt instruments. Climate bonds may be a model for new classes of asset including insurance projects. Essentially, funding can come from three types of sources: (1) national government, (2) development of pilot programmes and (3) payment from verified emissions reductions, that is, carbon offset schemes, as under the UNFCCC nations agree to individual emission reduction commitments which can be achieved through three flexible mechanisms: (1) international emissions trading, (2) joint implementation and (3) Clean Development Mechanism

Herr et al. (2015) have recently reviewed finance mechanisms for blue carbon projects. They point to an increasing interest by governments, NGOs, local communities and academia to support coastal wetland restoration and conservation, but observe that finding appropriate funding to set up such a blue carbon project or to develop a national scheme for blue carbon remains ‘a challenge’.

6.3.1 UNFCCC-Related and Other Finance Mechanisms

As noted earlier, the UNFCCC sets the framework for internationally agreed GHG reduction measures and provides technical details and funds to support a variety of climate mitigation activities including carbon mechanisms. Specific financial mechanisms under the UNFCCC umbrella include the **GEF** Trust Fund, the Special Climate Change Fund (**SCCF**), the Least Developed Countries Fund (**LDCF**), the Green Climate Fund (**GCF**) and the Adaptation Fund. Other multilateral and national climate funds include the BioCarbon Fund and other funds from the African and Asian Development Banks.

The list of possible sources is confusing and has been described as a ‘jungle’ (Herr et al. 2015). Herr et al. (2015) show how to start looking for funds within the multiple funding agencies. First, one needs to determine the type of activity, that is, whether it is starting up a national programme, subnational programme or an individual blue carbon project. Second, one needs to match up with a possible funding source, for example, in this case the Green Climate Fund or REDD+; national funds are also available such as IKI, NEFCO and GCPF. Third, development banks do provide funds for mid- (<$2 million US) to full-size (>$2 million US) projects although projects in this size range usually require government support. Fourth, one needs to decide on whether or not incremental or additional funds are necessary. For example, if biodiversity is a supplemental issue there are RAMSAR Small Grants or other sources such as biodiversity funds from development banks. Small projects under $500,000 US can fit well with foundations, charities or the private sector. Mid- and full-size projects are best funded by UNFCCC-related sectors such as the Global Environment Fund (**GEF**).

Some financing is best suited to specific habitat. For example, although the REDD+ financing mechanism is still being arranged, mangroves are well suited for REDD+ financing, being forests with similar ecological traits to terrestrial forests (Yee 2010; Ahmed and Glaser 2016; Mashayekhi et al. 2016). The main funding streams are those of the Forest Carbon Partnership Facility (FCPF) of the World Bank and UN-REDD. The former is a global partnership of governments, business, society and indigenous peoples and is broken up into two separate but complimentary funding mechanisms: The Readiness Fund and the Carbon Fund. Currently, there are 47 participating countries in these programmes (Herr et al. 2015). The UN-REDD programme is a collaboration among the UNDP, FAO and UNEP and supports national initiatives in 64 partner countries (Herr et al. 2015). Herr et al. (2015) list relevant online sites for available climate adaptation and mitigation funding.

6.3.2 *The Voluntary Carbon Market*

Blue carbon projects can also be funded via the voluntary carbon market. A good example of this type of project is in Madagascar (Table 6.2) and has been run by Blue Ventures since 2011. The project has two demonstration sites, one a large-scale (26,000 ha) mangrove project and the second a smaller project (1015 ha). Both are being used to test the feasibility of using blue carbon as a long-term financial mechanism for community-based mangrove management.

One of the pitfalls of the voluntary carbon market is that the price of carbon fluctuates over time, and this may affect the viability of a blue carbon project. For instance, Jerath et al. (2012) noted that the social cost of carbon (**SCC**) ranges from $9 US to $50 US per tonne of carbon while marginal abatement costs (**MACs**) vary from $70 US to $616 US per tonne of carbon. Both SCC and MACs are useful for setting a price for carbon in the absence of efficient carbon markets. Carbon prices also vary across countries and markets, and people's willingness to pay is expected to correspondingly increase with their view that carbon storage will provide significant profit.

The voluntary carbon market deals with the selling and buying of emission reduction credits (offsets) in non-government-regulated markets. The demand for verified carbon credits is market-driven, that is, by customer demand. There are many types of buyers in the market, from individuals who want to offset their carbon footprint from air travel to companies who themselves emit GHGs. Companies do this to enable themselves to be labelled clean and green. As discussed earlier, coastal carbon offset projects may be economically feasible at low to moderate carbon prices of $2 to $11 US per tonne CO_2-e. The majority of potential emissions from mangroves could be avoided at less than $10 US per tonne CO_2-e (Siikamäki et al. 2012).

Efforts are currently underway to develop methodologies for verifying coastal carbon credits. The Verified Carbon Standard (**VCS**) and American Climate Registry (**ACR**) are used globally to verify and issue carbon credits from field projects such as the one in Madagascar to be traded on the voluntary carbon market. Other standards include The Climate, Community and Biodiversity Standard (**CCB**), the CarbonFix Standard and the Plan Vivo Systems and Standard. Obviously, a blue carbon project that is going into the voluntary carbon market needs to find an appropriate standard as well as methodologies to measure, report and verify changes in carbon storage although no verified standard organisations have yet produced such accepted procedures.

Biodiversity can also be a focus of funding opportunities, as noted above. The Ramsar Convention maintains three direct assistance programmes: the Small Grants

Fund, the Wetland for the Future capacity-building programme and the Swiss Grant for Africa. These funds may be tapped into for a blue carbon project, but an analysis of cost-effectiveness still needs to be done for projects. Adame et al. (2015a; b) suggested using Marxan, a spatial prioritisation tool to balance the provision of ecosystem services versus the cost of restoration. Their approach efficiently selected restoration sites that at low cost were compatible with biodiversity targets; the restoration of biodiversity was largely guaranteed by choosing areas for restoration based on the potential for carbon storage.

Debt-for-nature swaps can also be an innovative, non-market way of financing. A debt-for-nature swap involves a lending country selling the debt owed by a recipient country (the debtor) to a third party at less than the full value of the original loan. In exchange the indebted country agrees to a payment schedule on the amount of the debt remaining. The third party then uses the debt repayments to support domestic conservation initiatives. An example of this type of funding mechanism is in the Seychelles where there has been a debt swap for conservation and adaptation (Herr et al. 2015). In this project, the Seychelles Debt Swap for Conservation and Adaptation between the Seychelles government and the Club of Paris developed through the platform of the Global Island Partnership with the technical support of The Nature Conservancy (TNC) develops a long-term funding stream for conservation activities.

Another pathway, as noted earlier, is via payment for ecosystem services. An example of this type of arrangement is in Ecuador where mangroves are held under preservation and protection agreements; by late 2018, it hopes to have 100,000 ha of mangrove forest under protection via a mix of fixed and variable payments. The fixed yearly payment amounts to $7000 US for areas between 100 and 500 ha, $10,000 US for areas between 501 and 1000 ha and $15,000 US for areas above 1000 ha. Variable payments depend on the size of the area as well amounting to a benefit of $3 US ha^{-1} $year^{-1}$. The PES schemes nonetheless offer the greatest scientific and policy challenges as accurate valuations will offer incentives for funding and private investment as well as improve management and governance of these resources.

There are problems with valuations that remain difficult to solve except on a case-by-case basis. First, there are a large number of services that are interlinked thus making it difficult to value one particular service. Second, as Bardesgaard (2016a; b) has noted, the commoditisation of nature might encourage perverse outcomes and represents a shift from conservation motives to economic self-interest, that is, the expectation of financial returns from investment. Third, valuation will depend on the rate of habitat loss; if current trends continue, less carbon will be sequestered, leading to a decline in value (Beaumont et al. 2014). An alternative is to consider the quality of environmental assets rather than ecosystem services. Quality assessments can then be quantitatively assessed (e.g. species richness, habitat quality, cultural values).

6.3.3 Investment Risk

Investment is all about risk. Risks need to be minimised in order to maximise the probability of a return on the investment. There is also a need to demonstrate the likelihood of attractive returns (Warner et al. 2016). This idea is constrained by (1) biophysical issues such as amount of carbon sequestered, measurement uncertainty and logistical challenges; (2) technical capacity and intrastructure; (3) concerns over governance (corruption, land tenure); (4) existence of regulatory frameworks; (5) permanence of the ecological asset; (6) security of property tenure; (7) the temporal scale of measurements (i.e. ecosystems need time to mature for increased carbon storage); and (8) the fact that there may need to be different policy instruments designed for the specific type of finance (e.g. publicly funded versus private investment).

6.3.4 Policy and Commodification

The science policy and management community have a few naysayers regarding blue carbon, and these problems must be addressed fully before blue carbon can mature as a viable business proposition. Broadhead (2011) cited the difficulty in marketing many ecosystem services that mangroves can provide as well as the lack of clarity over ownership of natural ecosystems. In almost all cases, the value of goods and services produced by mangroves has not been fully realised. In addition, the difficulty of realising the non-market benefits of mangroves is compounded by the fact that the benefits accrue to many people most of whom are poor. Broadhead (2011) further maintains that conversion of mangroves is generally associated with a change in ownership towards an individual or 'an established entity' while benefits are not commonly accessed across the local community. A range of numerous other problems need to be sorted, such as technical considerations associated with monitoring and quantifying carbon flow with precision. Also, setting baselines have meant that costs associated with these issues may exceed benefits.

Concerns raised by Barbesgaard (2016a, b) focus on the concept of 'ocean grabbing' in which private industry takes through ownership what is essentially common property. It is pointed out that social movements have called blue carbon projects a 'false solution' because of what may be the false belief that market logic provides the best tool to organise society and conserve nature. Commodification of nature involves large shifts in and struggles over social relations such as ownership of natural resources, socio-economic inequality and power. Under the blue carbon umbrella nature is reduced to a commodity to buy and sell violating the ideals of social justice. Barbegaard (2016a, b) points out that 'blue carbon projects act as a smoke-screen diverting attention away from the systematic changes needed to stop the climate crisis [. . . ..] polluting actors, be they states or transnational corporations [. . . ..] can continue to pollute and destroy one place as long as a coastal ecosystem that stores and absorbs carbon somewhere else is 'protected'. This idea is not a new argument as it originates from the old idea of corporations' land grabbing. The 21st Conference of the Parties to the UNFCCC closed with the initiation on the Paris Agreement on 12 December 2015 with a high level of collaboration from nations and corporations. However, radical transnational agrarian and social justice movements argue that the agreement will facilitate continued market-based resource grabs for land, forests and oceans through carbon trading schemes and related mechanisms (Tramel 2016). While there may be an element of truth in that perverse outcomes can eventuate, a proper policy framework that included safeguards can overcome these concerns.

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