

# The Management of Coastal Carbon Sinks in Vanuatu: Realising the Potential

Scoping and Feasibility Study



The Commonwealth

---

# The Management of Coastal Carbon Sinks in Vanuatu: Realising the Potential

SCOPING AND FEASIBILITY STUDY



The Commonwealth

---

Laffoley, D.d'A., 2013. The management of coastal carbon sinks in Vanuatu: realising the potential. A report to the Government of Vanuatu. Commonwealth Secretariat, London.

Commonwealth Secretariat  
Marlborough House  
Pall Mall  
London SW1Y 5HX United Kingdom  
© Commonwealth Secretariat 2013

All rights reserved. This publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or otherwise provided it is used only for educational purposes and is not for resale, and provided full acknowledgement is given to the Commonwealth Secretariat as the original publisher.

Views and opinions expressed in this publication are the responsibility of the author and should in no way be attributed to the institutions to which he is affiliated or to the Commonwealth Secretariat.

Wherever possible, the Commonwealth Secretariat uses paper sourced from responsible forests or from sources that minimise a destructive impact on the environment.

Printed and published by the Commonwealth Secretariat.

Photographs © Dan Laffoley

Used with permission

Cover photo credit: Dan Laffoley

# Foreword

**Commonwealth Heads of Government, when they met in Perth in October 2011, recognised the importance of ensuring sustainable management of our oceans as the basis for livelihoods, food security and economic development.**

---

The ocean is an essential part of the world economy – from the uses made of ocean space, the economic values we attach to it, the important goods and services it supplies, the wealth of resources it contains, to the activities it supports. Commonwealth countries have jurisdiction over globally significant ocean areas and for many small island and developing coastal countries, access to living and non-living marine resources plays a critical role in shaping their economic and social development. For the 27 small island developing states in the Commonwealth, the ocean and coasts lie at the heart of national development.

For such countries, the oceans are a source of food, resources and livelihoods, as well as playing a central role in regulating the global climate. Coastal habitats, in particular, play a critical role in climate regulation through the storage and sequestration of carbon. Mangroves, salt marshes, and sea grasses remove atmospheric carbon and incorporate it, along with trapped plant materials, into their soils (collectively known as coastal 'blue carbon'). Ecosystem services provided by coastal habitats also extend beyond carbon. As such, there is growing evidence and scientific consensus that the management of these coastal ecosystems, through conservation, restoration and sustainable use not only mitigates carbon emissions, it preserves and enhances biodiversity, protects coastal communities from natural hazards, and provides food from fisheries, as well as a habitat for juvenile fish to thrive in, thereby supporting livelihoods of coastal communities.

Despite growing acceptance of the importance of such habitats, it is clear that these blue carbon ecosystems are being degraded and destroyed

at an unprecedented rate. Disturbance from a variety of human activities, such as aquaculture, agriculture, forest exploitation, industry and urban development, are transforming coastal habitats causing the release of large amounts of sequestered carbon into the atmosphere. One way to counter these pressures, and thereby conserve the carbon stored in these habitats, is to recognise the true 'carbon value' of coastal ecosystems in national carbon inventories and to establish policies that take the value of coastal carbon into account in decision making processes that influence and affect development of coastal habitats.

This report represents the first study by the Commonwealth Secretariat of the potential 'blue carbon' opportunity in a Commonwealth country. In this regard, The Government of the Republic of Vanuatu is among the first in the world to seriously examine the role and potential of blue carbon at a national level. Of the top ten countries with the largest areas of mangrove, six are Commonwealth countries,<sup>1</sup> accounting for approximately 25% of global mangrove coverage. Many other Commonwealth countries have smaller but nonetheless significant areas of mangrove, and seagrass habitats, thereby presenting a significant opportunity to show global leadership in the global climate change policy arena. This report therefore provides an important analysis that other Commonwealth countries should find instructive in their own consideration of the opportunities presented by blue carbon.

<sup>1</sup> The six are: Australia, Bangladesh, India, Malaysia, Nigeria and Papua New Guinea.

# Acknowledgments

A wide range of people have contributed to the development of this report. In particular in Vanuatu the assistance of Toney Tevi and Sheena Luankon from the Department of Foreign Affairs is gratefully acknowledged for their advice and in making the field visit run smoothly.

Francis Hickey provided invaluable background and advice, as did Jennifer Corrin, Director for the Centre for Public, International and Comparative Law in Brisbane, Australia.

Dorothee Herr reviewed a draft of this report, and her comments and advice for improving the text are gratefully acknowledged.

# Contents

Foreword .....	iii
Acknowledgments .....	iv
Summary .....	vi
Acronyms and Abbreviations .....	viii
1. Introduction .....	1
2. Importance of blue carbon ecosystems .....	4
3. Blue carbon global policy frameworks and practical actions .....	7
4. Current state of knowledge of blue carbon ecosystems in Vanuatu .....	11
5. Vanuatu blue carbon preparedness .....	14
6. Benefits of recognising the benefits of blue carbon .....	18
7. Barriers to implementation of blue carbon in Vanuatu .....	21
8. Opportunities for fast-track implementation .....	23
9. Next steps .....	25
10. Recommendations .....	26
11. Conclusions .....	27
12. Glossary .....	28
13. References .....	29
Annex 1. National and regional climate change adaptation and mitigation programmes, projects and initiatives relevant to blue carbon .....	31
Annex 2. Experts met during the visit to Vanuatu .....	34
Annex 3. Experts on blue carbon .....	35
Annex 4. Blue carbon explained: a quick summary .....	36
Annex 5. Carbon quantification methodologies .....	38

# Summary

**It is only comparatively recently that recognition has been given to the body of evidence showing that coastal and marine ecosystems, such as mangroves and seagrass meadows, also contain appreciable amounts of carbon stored in the soil and sediment that lie beneath the surface of the seabed.**

---

Until recently most people considered that the main ecosystems that lay at the heart of climate change adaptation and mitigation activities were forests, peatlands and perhaps some types of soils. These ecosystems form important coastal carbon sinks, also termed 'blue carbon'. Damage to and destruction of these habitats can lead to greater emissions of carbon dioxide back into the air and ocean per unit area than occurs from forests and peatlands, thus increasing emissions of this greenhouse gas, and thereby significantly contributing to the main cause of climate change.

Islands in the Pacific are amongst the first to be affected by climate change although they have done little to contribute to the cause – contributing less than 0.03% of current global greenhouse gas emissions. Most islands are now experiencing climate change impacts, whether at the coast, on agriculture, infrastructure, water supply, coastal and forest ecosystems, fisheries, or on communities and their health.

This report explores the opportunities that recognising blue carbon could bring to Vanuatu. Commissioned by the Government of Vanuatu from the Commonwealth Secretariat, it sets out the opportunities, supportive arguments, and issues and potential barriers around incorporating blue carbon as part of their overall climate change adaptation and mitigation strategy. While a number of blue carbon projects elsewhere are focused primarily (or solely) on monetising the financial value of carbon through carbon credit schemes or similar, the Commonwealth Secretariat believes this to be an inherently risky strategy. Carbon prices may vary or crash, and such an approach is often at odds with cultural and societal values, especially in the Pacific region.

This report takes a broader look at the full range of values blue carbon can hold for Vanuatu, describing the values of blue carbon habitats,

what is already known about such habitats in Vanuatu, and how existing projects and initiatives can help form a useful basis from which to proceed. As such it may act as a blueprint for studies elsewhere in the Pacific and more widely, though the exact mix of recommendations made here are specific to Vanuatu. This is due to the relatively small area of blue carbon habitats present, but also the strong and intimate links through customary stewardship between local communities and the health and wellbeing of their surrounding environment.

The report makes 12 major recommendations stemming from this analysis and the overall conclusion of the net positive effect that would be achieved from implementing a blue carbon initiative in a stepwise approach, in isolation, or with other countries in the region.

The report concludes that blue carbon presents a new and real opportunity for Vanuatu, but cautions that an inherently risky strategy of focussing predominantly on monetising the potential financial value of the stored carbon should be avoided. Indeed the overall conclusion is that the raft of potential wider benefits associated with blue carbon probably outweighs the financial value of carbon for Vanuatu. This is especially the case due to the relatively small area of such habitats in the islands, and acknowledging the fundamental importance of the close ties villages and communities, and their wellbeing, have to such natural resources. Aligning any potential blue carbon work on mangroves with activities already underway through REDD+ is another important action to be achieved early on in the process.

The clear leadership Vanuatu has already shown on blue carbon could proceed with added impetus and evidence if work is started to realise some of the potential benefits associated with their coastal carbon sinks.

The recommendations focus on a suite of blue carbon activities:

- complete the accurate mapping and inventory of mangroves started by MESCAL;
- undertake mapping of the seagrass meadow distribution in nearshore waters;
- undertake carbon content analysis for mangroves and seagrass meadows to quantify the scale and variability of the carbon sink;
- complete (as needed) work started by MESCAL on socio-economics associated with mangroves and seagrass meadows to provide a full quantification of the ecosystem goods and services and associated trends provided by these habitats;
- clarify customary rights and practice relating to stewardship, and review and amend as necessary legislation and policy frameworks to include blue carbon;
- continue to develop and extend governance frameworks to the coast and nearshore areas to best define carbon responsibilities and ownership by communities and government, perhaps through convening an 'Ocean Summit';
- ensure that current policy and management approaches explicitly include blue carbon, especially land use planning and environmental impact assessments;
- undertake sustained actions around outreach, education and conversations with local communities to build understanding, responsibilities and practical programmes of activities to best manage and protect the blue carbon resources;
- continue to grow regional political cooperation to build opportunities to implement blue carbon in Vanuatu and other countries in the region;
- open dialogue with donors, particularly those active in Vanuatu (e.g. AusAID) or in the region, to explore funding opportunities and complementarities to existing donor initiatives;
- partner blue carbon work in Vanuatu with similar initiatives in other countries in the region to accelerate progress and build capacity and expertise, and consider the join up to REDD+ activities already underway in so doing; and
- engage with international work on blue carbon science and policy to draw in knowledge and expertise, either directly or through regional working.

# Acronyms and Abbreviations

<b>ACR</b>	American Climate Registry
<b>APEC</b>	Asia-Pacific Economic Cooperation
<b>CBD</b>	Convention on Biological Diversity
<b>CDM</b>	Clean Development Mechanism under UNFCCC
<b>FCPF</b>	Forest Carbon Partnership Facility
<b>GPA-Marine</b>	UNEP Global Programme of Action for the Protection of the Marine Environment from Landbased Activities
<b>ha</b>	Hectare – a measure of area. 1 ha = 0.01 square kilometer
<b>LULUCF</b>	Land Use, Land-Use Change and Forestry
<b>MEAs</b>	Multi-lateral Environmental Agreements
<b>MESCAL</b>	Mangrove Ecosystems for Climate Change Adaptation and Livelihoods
<b>MRV</b>	Measuring, reporting and verification under REDD+ schemes
<b>NAMA</b>	Nationally Appropriate Mitigation Action
<b>ORSTOM</b>	Office de la Recherche Scientifique et Technique d’Outre-Mer (French)
<b>Ramsar</b>	Ramsar Convention on Wetlands
<b>REDD+</b>	Reducing Emissions from Deforestation and Forest Degradation mechanism related to the UNFCCC
<b>Rio +20</b>	UN Conference on Sustainable Development
<b>SPREP</b>	Secretariat of the Pacific Regional Environment Programme
<b>tCO<sub>2</sub>e</b>	Tonnes of carbon dioxide equivalent
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>VCS</b>	Verified Carbon Standard

# 1. Introduction

The revelation to many people that coastal ecosystems such as mangroves and seagrass meadows trap and store vast quantities of carbon has created new interest for exploring the role of these ecosystems in climate change adaptation and mitigation schemes.

Information made available within the last four years shows how the natural carbon capacity and green infrastructure of key ecosystems at the coast can be used to help tackle the increasing problems being encountered from climate change. The revelation to many people that coastal ecosystems such as mangroves and seagrass meadows trap and store vast quantities of carbon (Laffoley & Grimsditch 2009, Nellemann *et al* 2009) has created new interest for exploring the role of these ecosystems in climate change adaptation and mitigation schemes. These same ecosystems are already known to provide many other services to humanity, such as protection from coastal

erosion and buffering storm surges and tsunamis (McIvor *et al* 2012). So the addition of carbon sinks opens up new opportunities for valuing the services provided by these ecosystems. The publication of the World Development Report 2010: Development and Climate Change (The World Bank 2010a) and The World Bank's Convenient Solutions to an Inconvenient Truth (The World Bank 2010b) also underscore the importance of harnessing natural systems including wetlands, and the carbon storage services they provide, in the fight to reduce carbon emissions.

Recognising the value of natural capital at the coast is now seen as one of the essential elements for



coastal and island States in building a successful green economy (Laffoley 2012). Incorporating the diverse opportunities that coastal habitats can provide, to support communities, and also to save money through working with the natural buffers that these ecosystems provide, is a very real and tangible way by which Governments of vulnerable countries can better prepare for the future. Approaches that recognise the true 'carbon' value of coastal ecosystems as part of ecosystem-based mitigation also fit well with global best practices emerging for planners and managers on tackling climate change (CEC 2012, Munang *et al* 2013), and display characteristics that suggest effective uptake can result in the reform of often inadequate existing policy, legislation and decision making (Kushner *et al* 2012).

## Understanding and implementing the opportunities blue carbon presents would be an important factor to help drive progressive development of the overall governance and economic framework for Vanuatu.

Within the Pacific region recognition of these 'coastal and marine ecosystem carbon sinks' – often referred to as 'blue carbon' – is very timely. In 2012 The World Risk Report (Mucke 2012) identified Vanuatu as the country in the world with the highest natural risk exposure. The country is often hit by cyclones and is vulnerable to the effects of climate change and natural disasters. Building the link between such threats and the mitigation role of blue carbon is therefore important. Vanuatu is already a world leader on blue carbon and within the last few years has spoken on behalf of the Melanesian Spearhead Group (MSG)<sup>2</sup> of the need to embrace blue carbon in climate change mitigation schemes at a global level, and has also continued to champion the issue within the Pacific regional context.<sup>3</sup>

The MSG members are joining together to take a stand against climate change in the knowledge of the critical role that sustaining a healthy environment plays for the long term livelihoods of their peoples. They recently signed the "MSG Leaders Declaration on Environment & Climate Change".<sup>4</sup> In taking this stand leaders have recently called for a "Melanesia Blue Carbon Initiative" that

will recognise the significant role of mangroves, wetlands, coastal swamps and sea grass beds in removing carbon from the environment. These actions in turn are part of a bigger Pacific-wide concerted action on climate change adaptation and mitigation, of which Vanuatu is a core member (Pacific Islands Forum, 2012) (Annex 1 provides further details of major blue carbon relevant national and regional Pacific climate change projects and programmes).

Alongside and within the Melanesian context the Commonwealth Secretariat was recently asked by the Government of Vanuatu to assist them with an assessment of the feasibility of setting up a specific blue carbon project for Vanuatu, whether this be in terms of an overall strategic approach or a specified area based, on-the-ground project. This is as part of developing their broader ocean governance framework and is the focus for this report. The proposed blue carbon initiative would build on a body of work that has developed in recent years to recognise the importance of their coastal habitats through projects such as MESCAL (Mangrove Ecosystems for Climate Change Adaptation and Livelihoods). Recognition of Amal Crab Bay as a possible future Ramsar site (Vai Jungblut, pers. com. 2013) is also relevant to any blue carbon work, as well as activities already underway regionally on preparing the basis for implementing climate change mitigation carbon schemes (Vickers, Ogle and Speight 2011). Work on the national REDD+ strategy and forest carbon rights provides a wealth of information and experience which is directly relevant to implementation of blue carbon (Corrin 2012).

Understanding and implementing the opportunities blue carbon presents would be an important factor to help drive progressive development of the overall governance and economic framework for Vanuatu. This report takes a broad look at what these opportunities might look like, and in doing so sets the emphasis

<sup>2</sup> The Melanesian Spearhead Group is an intergovernmental organization, composed of the four Melanesian states of Fiji, Papua New Guinea, Solomon Islands and Vanuatu as well as New Caledonia. It was founded as a political gathering in 1983. On 23 March 2007, members signed the Agreement Establishing the Melanesian Spearhead Group, thereby formalizing the group.

<sup>3</sup> <http://www.sprep.org/environmental-monitoring-governance/msg-uses-rio20-to-promote-its-climate-change-declaration>

<sup>4</sup> <http://www.msgsec.info/index.php/publicationsdocuments-a-downloads/press-release/152-msg-declaration-on-environment-and-climate-change->

seen elsewhere on realising the financial value of the stored carbon into a more appropriate socio-environmental context better suited for the Melanesian context, and the Pacific region more broadly. Customary stewardship in Vanuatu demonstrates the need and value of taking such a broader view. Blue Carbon initiatives with a predominant focus on just realising financial values of the stored carbon are a risky strategy. The fall in carbon prices at the end of 2011, from a high of €17.42 a tonne down to €6.60 by the start of 2013, and now down as low as around €3 a tonne, demonstrates the volatility that this market can display.

It is hoped that the analysis given here will help further evolve legislation, policy and practical actions that are needed to underpin and sustain Vanuatu's low carbon economic growth, and important traditional and social values. It is intended that the model set out here may be of relevance more broadly in the region as a blueprint to assess the multifaceted benefits that blue carbon can bring.

The content for this study has been developed as a result of a number of visits to Vanuatu by the Commonwealth Secretariat, including a field visit (Port Villa and Malekula) between 3rd and 12th February 2013 to meet with Government officials, experts and community stakeholders. This visit provided the opportunity to gain an overview of the status of conservation and management of mangroves and seagrass meadows, an opportunity to hear the perspectives from community

stakeholders, to see existing work on which a blue carbon project could be developed, and to understand the opportunities as well as issues that implementing a blue carbon project could present.

Individuals with whom discussions were held during the visit are listed in Annex 2. The report also draws on the considerable and increasing wealth of experience on the science and implementation of blue carbon through a variety of projects and initiatives around the world. Further information on international science and policy contacts is provided in Annex 3.

The objectives of this study are three-fold:

1. To undertake a baseline study of the position of Vanuatu with regard to blue carbon;
2. To assess the feasibility of a blue carbon project for Vanuatu, including the arguments for and against doing so for the government of Vanuatu and the community stakeholders; and
3. Should such a project be considered feasible, to make recommendations on how best to progressively realise that opportunity.

## 2. Importance of blue carbon ecosystems

**Understanding the opportunity blue carbon presents Vanuatu with, is to understand the importance and potential of blue carbon ecosystems.**

---

Understanding the opportunity blue carbon presents Vanuatu with is to understand the importance and potential of blue carbon ecosystems. This is built around the rapid development in science and knowledge that has occurred in the past few years about the carbon trapped in these ecosystems, and how blue carbon compares to carbon in terrestrial ecosystems - already the focus for much climate change mitigation activity.

The conservation and restoration of forests, peatlands and some soil types on land is universally recognised and valued as an important element of climate change mitigation strategies. These ecosystems are valuable for climate change mitigation because over long periods of time they capture and store carbon in very large volumes, although over time they also are reduced in effectiveness as they reach a mature steady state. The carbon is trapped by plant growth and effectively locked away in vegetation in these natural 'carbon sinks'. If these ecosystems are degraded or damaged by human activities then their carbon sink capacity is lost; the cumulative carbon that has been stored is liberated back into the atmosphere, resulting in large emissions of carbon dioxide (CO<sub>2</sub>), which in turn then make a significant contribution towards climate change.

Conserving and restoring terrestrial forests, and more recently peatlands, has, therefore been recognized as an important component of climate change mitigation action. Several countries are developing policies and programmes in support of sustainable development through initiatives that reduce the carbon footprint associated with the growth of their economies, including actions to conserve and sustainably manage natural systems relevant to the United Nations Framework Convention on Climate Change (UNFCCC) and the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism.<sup>5</sup>

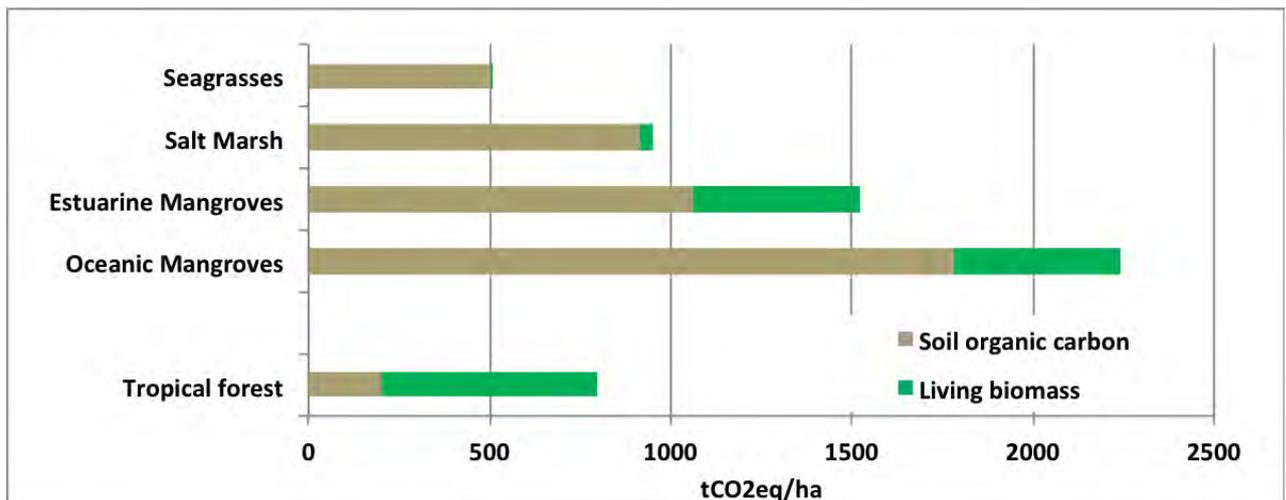
Given their carbon function there is growing evidence and scientific consensus that the management of these coastal ecosystems has strong potential to be a transformational tool in sustainable livelihoods and a valuable part of global natural carbon management.

It is now known that coastal ecosystems, such as tidal marshes, mangroves and seagrass meadows similarly provide carbon sequestration, and store large quantities of carbon in both the plants and in the sediment below them. Occupying just 2% of seabed area, these vegetated wetlands represent 50% of carbon transfer from oceans to sediments (Duarte, Middelburg & Caraco 2005). Unlike forests and peatlands they achieve this by a sustained sequestering of carbon, which doesn't reduce in effectiveness over time if these ecosystems are free to respond to changes in sea level. As a group of wetland types that have a global occurrence they therefore create new opportunities and infer new responsibilities on many nations that have them within their marine waters.

Per unit area, blue carbon coastal ecosystems are now understood to be significantly better at trapping and storing carbon than their terrestrial counterparts (Figure 1). This is because the carbon laid down through natural processes is packed away more tightly (higher bulk density), and because the salinity of seawater can hinder the production of other gasses associated with decomposition

<sup>5</sup> Reducing Emission from Deforestation and Forest Degradation, conservation of forests, the sustainable management of forests and the enhancement of forest carbon stocks.

**Figure 1.** The comparative average amount of carbon stored above and below ground in blue carbon ecosystems, and how this compares to tropical forest carbon (The Nicholas Institute for Environmental Policy Solutions at Duke University; <http://nicholasinstitute.duke.edu>).



of vegetation, such as methane, which are more powerful greenhouse gases than CO<sub>2</sub><sup>6</sup> (Table 1). A longer outline summary of the science and evidence on coastal carbon sinks is provided in Annex 4.

Given their carbon function there is growing evidence and scientific consensus that the management of these coastal ecosystems has strong potential to be a transformational tool in sustainable livelihoods and a valuable part of global natural carbon management. Unfortunately action needs to be taken fast as these blue carbon ecosystems are being degraded and destroyed faster than forests and peatlands. Between 1980 and 2005, about 20% of the total global area of mangroves has been lost (Spalding, Kainuma & Collins 2010), whilst nearly 30% of seagrass meadows have been lost globally since the 19th century (Waycott et al 2009), with an upsurge in the recent decades. Large scale losses from clearing

and development as well as piecemeal losses and degradation of suitable habitat due to pollution are the major causes.

Preventing the loss of these ecosystems is critical since, in addition to the biodiversity values they support, these habitats provide a range of other significant benefits for climate change adaptation, local livelihoods and tourism and culture. These benefits include, but are not limited to providing protection from storms and prevention of shoreline erosion, regulation of coastal water quality and providing a habitat for numerous marine species.

Within the national context the importance of blue carbon for Vanuatu can be evaluated from a number of different perspectives –

- *Political dimensions* – does blue carbon provide new opportunities for the Government of Vanuatu to show and sustain leadership at both the regional and international level?
- *Governance and management decision making* – would including consideration of blue carbon in environmental decision making

<sup>6</sup> Methane for example has approximately 21 times the greenhouse gas potential that CO<sub>2</sub> has.

**Table 1. Summary of potential GHG reductions due to soil building in coastal wetlands (Philips Williams & Associates Ltd & Science Applications International Corporation (SAIC) 2009).**

Wetland type	Carbon sequestration	Methane production	Net GHG sink
Mudflat (saline)	Low	Very low	Low to medium
Salt Marsh	High	Very low	High
Freshwater Tidal Marsh	Very High	High to Very High	Neutral or variable
Estuarine Forests	High	Low	High
Mangroves	High	Low to High*	Low to High*
Seagrass Meadows	High	Low	High

\* depends on salinity

- support development of better governance systems and lead to better decision making on development and planning?
- *Community stakeholders* – could embracing blue carbon lead to enhanced sustainable resource management and better recognition of the importance of community contributions and customary stewardship?
  - *Biodiversity conservation and protection* – does recognising the carbon carrying capacity of coastal habitats make it more likely that they will be protected and better managed?
  - *Economic initiatives* – would including blue carbon provide new economic opportunities and provide increased potential in other areas, and become a critical component of a low carbon economy?
  - *Sustainable tourism* – does blue carbon implementation support or create tourism opportunities?
- Consideration of these different perspectives forms the basis of discussion in this report on the benefits that blue carbon could bring to Vanuatu and the issues that need to be taken into account.

# 3. Blue carbon global policy frameworks and practical actions

Scientific understanding of carbon sequestration and potential emissions from coastal ecosystems is now sufficiently well developed to inform the development of effective carbon policy, management, and conservation incentives for coastal blue carbon – in particular mangrove carbon.

Scientific understanding of carbon sequestration and potential emissions from coastal ecosystems is now sufficiently well developed to inform the development of effective carbon policy, management, and conservation incentives for coastal blue carbon – in particular mangrove carbon. A number of mechanisms are available which could be used to support Blue Carbon activities, some of which are more advanced than others to deliver actual implementation. These are briefly presented below:<sup>7</sup>

*The United Nations Framework Convention on Climate Change (UNFCCC)*

**REDD+.** In 2010, Parties to the UNFCCC at COP 16 recognized and encouraged developing countries to contribute to mitigation actions by the forest sector through REDD+ activities that (a) Reduce emissions from deforestation; (b) Reduce emissions from forest degradation; (c) Conserve forest carbon stocks; (d) Sustainably manage forests; and (e) Enhance forest carbon stocks.<sup>8</sup> REDD+ provides a framework suitable for financing management activities that reduce emissions from mangrove deforestation and reduce emissions and enhance removals from activities related to the use of those systems.

**Nationally Appropriate Mitigation Action (NAMA)** – refers to a set of policies and actions that developing countries undertake as part of national actions to reduce greenhouse gas emissions.

<sup>7</sup> Details of the actions needed to bring these five areas 'to market' for blue carbon are described in Blue Carbon Policy Framework 2.0 (Herr, Pidgeon, and Laffoley 2012).

<sup>8</sup> UNFCCC Decision 1/CP.16 The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention paras 68-79.

The term recognizes that different countries may take different nationally appropriate action on the basis of equity and in accordance with common but differentiated responsibilities and respective capabilities. It also emphasizes financial assistance from developed countries to developing countries to reduce emissions.<sup>9</sup>

#### **The Clean Development Mechanism**

(CDM)<sup>10</sup> – The CDM is a robust standard that is strictly regulated by the UNFCCC. Due to this, carbon credits under the CDM have a much higher value. However, the CDM process can sometimes be long and complicated. Two mangrove methodologies are available.

#### **Land Use, Land-Use Change and Forestry**

(LULUCF) – Developing countries (non Annex-1 countries) to the Convention must submit national communications on implementation of the Convention to the Conference of the Parties (COP). The core elements of the national communications are information on emissions and removals of greenhouse gases (GHGs) and details of the activities a Party has undertaken to implement the Convention. This includes a section on **Land Use, Land-Use Change and**

<sup>9</sup> UNFCCC Decision 1/CP.16 The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention paras 48-67.

<sup>10</sup> The Clean Development Mechanism (CDM), defined in Article 12 of the Kyoto Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO<sub>2</sub>, which can be counted towards meeting Kyoto targets. See [http://unfccc.int/kyoto\\_protocol/mechanisms/clean\\_development\\_mechanism/items/2718.php](http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php)

**Forestry** (LULUCF). Developing countries are encouraged to use the latest IPCC guidance to conduct their inventories.

#### *Voluntary carbon markets*

**The Voluntary Carbon Market** – a number of carbon market facilities that can potentially include blue carbon activities have been established outside the UNFCCC. Organizations like the Verified Carbon Standard (VCS) or the American Climate Registry (ACR) are used by carbon mitigation projects globally to verify and issue carbon credits for the international voluntary offsets market. This lower level of regulation results in a lower price per carbon credit. However, the voluntary carbon market process can be shorter and more flexible. This may be beneficial for smaller projects or projects types that are not applicable under the CDM.

#### *Demonstration sites<sup>11</sup>*

**Blue carbon projects** – Numerous stakeholders have started development of local and national projects. To ensure maximum efficiency, knowledge transfer and international recognition of these projects, these projects must be coordinated and networked effectively. Further, funding must be strategically targeted at expanding the network of pilot project sites. Criteria for selecting priority sites for funding should include: demonstrating and testing a range of relevant activities in a range of geographic locations; ease of implementation (including political environment); implementation capacity; social and community acceptability; data and information availability; speed to carbon credit creation; and potential for capacity building.

#### *Other international, regional and national frameworks and policies*

**Multilateral Environmental Agreements** (MEAs) – several international ocean and coastal policy frameworks already make reference to the conservation, sustainable use, restoration of and reduced emissions from coastal ecosystems for climate change mitigation. They include: the Convention on Biological Diversity (CBD), Ramsar Convention on Wetlands (Ramsar), UN Conference on Sustainable Development (Rio +20), United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea, UNEP Global Programme of Action for the Protection of the Marine Environment from Landbased Activities (GPA-Marine), alongside regional ocean and coastal

policy frameworks such as South Pacific Regional Environment Programme (SPREP) and Asia-Pacific Economic Cooperation (APEC). These policy frameworks raise overall recognition, improving management activities and provide some financial support for coastal blue carbon ecosystems management.

#### *Ecosystem services*

**Integrated accounting of ecosystem services** – the International Blue Carbon Policy Working Group<sup>12</sup> identified the inclusion of the carbon value of coastal ecosystems in an integrated accounting of ecosystem services as an overarching Blue Carbon Policy Objective. Additional efforts should consider how to best include the carbon value of coastal ecosystems in the accounting and payment of other ecosystem services, especially in light of the multiple ecosystem services each of these coastal ecosystems provides.

The above list is, however, provided with some caution. There are various challenges with some of the mechanisms – primarily led by concerns over REDD+ schemes. Concerns are both technical and social.

From a technical perspective there is some way to go to harness this aspect of the UNFCCC as up to now:

- *Key blue carbon countries have been omitted*  
Several key blue carbon countries have not availed themselves of the early stage “REDD-readiness” funding, such as those administered by the World Bank’s Forest Carbon Partnership Facility, to develop plans and capacity for implementing REDD+ activity and so are missing.
- *Soil and wetland MRV (measuring, reporting and verification) is predominantly absent from current REDD+ schemes*  
Not surprisingly the focus up to now has been on above-ground carbon so coastal ecosystems provide a new dimension to be tackled with MRV. Current draft decisions on MRV and monitoring however support a stepwise approach to MRV and allow for a phased approach for national forest monitoring systems which will allow for flexibility and improvements over time. New and better data, improved methodologies and information about mangroves can be included over time, including on the soil carbon pool, and

<sup>11</sup> <http://thebluecarboninitiative.org/encouraging-study-shows-blue-carbon-demonstrated-in-the-field/>

<sup>12</sup> <http://thebluecarboninitiative.org/category/working-groups/policy/>

- *The basis for engagement with coastal stakeholders remains unclear*

On land where there are mainly well established ownership and tenure systems the parties to engage in consultation are clear, but with coastal ecosystems the local communities are either not the 'landowner' in the terrestrial sense, or ownership is through customary law and often undocumented.

There are also concerns about how competitive blue carbon projects, if included, would be against other activities (Brian Murray – pers.comm. 2012).

On the social side, concerns with REDD+ predominantly relate to proper engagement with communities and their rights. A selection of the principle issues of concern (derived from Lang, 2012) relate to:

*More money is not necessarily the cure for community problems*

Challenges around demarcation of indigenous lands, healthcare and education are often the result of lack of political will and preferential treatment of large land owners, rather than simply a lack of money.

*Ecosystem services promote a reductionist and mercantile view of the forest*

Local communities view the forest as much more than a "carbon sink" or "environmental service provider." REDD projects and environmental services emphasize the economic aspects and can ignore and subvert the holistic view that local people traditionally hold.

*Decision-making processes are top down and authoritarian*

The accusation is that environmental services policies such as REDD are being implemented by governments in a unilateral, accelerated, and forced manner on local communities.

*Consultations are insufficient and questionable*

"Consultations" are seen to be restricted to NGOs, organizations, and government-financed institutions. The government "strengthens" these leaders and then accepts their consent as if it were representative of all communities. The more communities are excluded from the consultation process, the greater the number of people articulating resistance against REDD.



*Territorial sovereignty is under threat*

In order for local communities to maintain their ways of life and protect natural resources, they must have 'sovereignty' over their territory. This means not only physical land demarcation or ownership titles, but includes the customary stewardship right of these peoples to manage their resources. Contracts for the provision of environmental services can interfere with territorial and environmental management as undertaken by communities.

*Impacts beyond the territory*

The logic of "compensation" for emissions or environmental damage is strange to the thinking of some local communities with a close affinity to their environment. Promoting preservationist projects in one place while exposing communities and ecosystems to pollution or degradation somewhere else is often seen as contrary to the spirit of the forest.

Acting on such concerns, and with appropriate and timely effort on these five areas, increased recognition of the importance of these systems will provide a basis for strengthening the stewardship

role of communities and possibly for incentives, including financial mechanisms such as grants, to conserve or restore these systems and reduce emissions as well as impacts.

From an economic standpoint, mangroves are already eligible for the allocation of carbon credits under the UNFCCC market mechanisms, through two reforestation methodologies under the CDM, but careful development of any demonstration projects will be needed. For other coastal ecosystems, such as seagrass meadows, schemes are less well developed as more data on emission models, for example, is needed and is being developed. The bilateral funding arrangements and emissions markets that have been leveraged to pay for carbon sequestration and storage in forests (REDD+) could be harnessed to prevent coastal habitat loss. However, traditional sequestration projects and projects to conserve blue carbon differ in fundamental ways. The key is to identify and design financing mechanisms that will make carbon in coastal habitats eligible for payments, whilst strengthening the customary stewardship role of communities.

## 4. Current state of knowledge of blue carbon ecosystems in Vanuatu

No blue carbon implementation projects are currently underway in Vanuatu, though initiatives in the region and in Vanuatu itself work on blue carbon habitats and so are highly relevant to discussions.

Two blue carbon ecosystems occur in Vanuatu – mangroves and seagrass meadows. In broad terms much more is known about Vanuatu's mangroves than is known about the seagrass meadows. No blue carbon implementation projects are currently underway in Vanuatu, though initiatives in the region and in Vanuatu itself work on blue carbon habitats and so are highly relevant to discussions.

As such these initiatives provide a good basis for the development of baseline understanding of blue carbon on which to develop any future blue carbon approach. These supportive initiatives are introduced below and in subsequent chapters.

Within the Pacific region, Melanesian countries support a significant proportion of the world's mangrove and seagrass areas relative to their size. Recent estimates indicate that mangroves cover an area of approximately 5,244 km<sup>2</sup> in the Pacific islands. They account in Papua New Guinea for 3,728 km<sup>2</sup> (considered to be a low estimate – Eric Verheij pers. comm. 2013), the Solomon Islands 642 km<sup>2</sup>, Fiji 410 km<sup>2</sup>, New Caledonia 202 km<sup>2</sup> and Vanuatu 27 km<sup>2</sup> (MSG 2013).

The total area of seagrass meadows in these five countries is currently not well understood, as no overall broad scale mapping exercise has been conducted (MSG 2013). Within Vanuatu the seagrass communities were last surveyed and described in 1988, through work funded by the Australian International Development Assistance Bureau (Chambers *et al.* 1990). This research describes the species present through widespread spot sampling, but did not undertake detailed distribution mapping. From this work nine species of seagrass are known to be present, with the most widespread species being *Thalassia hemprichii*, *Cymodocea rotundata*, *Halodule inermis*, *Enhalus*

*acoroides* and *Halophylla ovalis*. The most extensive seagrass meadows are in the wider intertidal areas along the south east coast of Malekula and around the Maskelyne Islands. Elsewhere smaller dense meadows occur in sandy sediments.

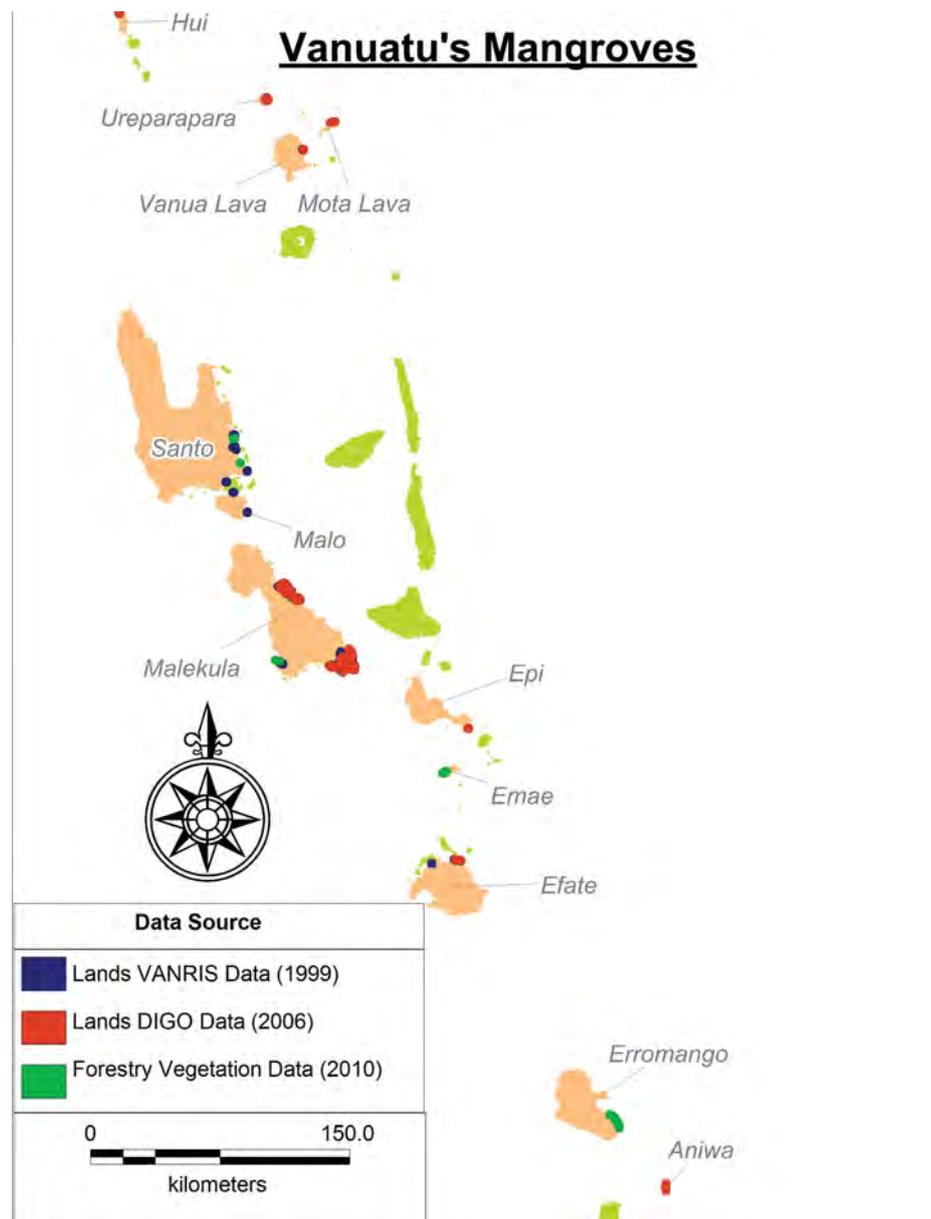
In Vanuatu mangroves form the most extensive wetland vegetation type (Bani and Esrom 1993) and they occur on nine of the islands, including Hiu, Ureparapara, Vanualava, Motalava, Malekula, Epi, Emae, Efate and Aniwa. The largest areas, some 20 km<sup>2</sup> in total, occur on Malekula at Port Stanley/Crab Bay area (Figure 3) and in the Maskelyne Islands/Lamap area. Elsewhere mangroves occur as small stands or narrow fringing systems along the edges of lagoons, estuaries and the coast.

Despite the overall picture of mangrove distribution in Vanuatu, comprehensive detailed and accurate mapping of individual mangrove areas on all the islands is still lacking. Improving knowledge of the mangroves is currently the focus of the MESCAL project funded by the German Federal Ministry for the Environment, Nature and Conservation and Nuclear Safety (BMU) under its International Climate Initiative.<sup>13</sup>

MESCAL was established in 2009 to increase the resilience of Pacific Island communities to the effects of climate change and to improve their livelihoods through selected capacity support in adaptive co-management and restoration of mangroves and associated ecosystems.<sup>14</sup> Vanuatu is one of the five countries participating in this

<sup>13</sup> For further information refer to <http://www.bmu-klimaschutzinitiative.de/en/news>.

<sup>14</sup> [http://www.iucn.org/about/union/secretariat/offices/oceania/priorities/priority\\_naturebased\\_solutions/water\\_wetlands/about/resources/newstories/?12609/MESCALprojectreview](http://www.iucn.org/about/union/secretariat/offices/oceania/priorities/priority_naturebased_solutions/water_wetlands/about/resources/newstories/?12609/MESCALprojectreview)



**Figure 2.** The distribution of mangroves in Vanuatu, showing demonstration sites for the MESCAL project and main sources of underlying information. Islands shown in light green have unconfirmed mangrove presence, whilst those marked in salmon pink have confirmed presence of mangroves (MESCAL 2013).

work, alongside Fiji, Samoa, Solomon Islands, and Tonga. Any future blue carbon work will greatly benefit from the information obtained through this initiative. MESCAL is already gathering together national baseline information about climate change scenarios, alongside the use and values of mangroves and associated ecosystems. It aims to improve co-management of mangroves, improve the conservation and/or restoration of mangroves at selected demonstration sites, alongside increasing awareness, advocacy and capacity development.

One of the challenges faced in Vanuatu by the MESCAL project has been obtaining accurate maps of mangroves – a prerequisite for understanding

the scale of the blue carbon resource and managing it effectively. Multiple standalone baseline digital datasets have existed for some time showing broad-scale distribution. These are from the Lands and Forestry Departments, as well as hard copy vegetation maps showing mangroves created by Office de la Recherche Scientifique et Technique d’Outre-Mer (ORSTOM) in the late 1970’s.

A key problem with these datasets/hardcopy maps is that they have an incomplete coverage, and that their accuracy and currency is questionable. This situation has been further complicated by some old data having being lost (e.g. Mangrove Location Data



**Figure 3.**  
Mangroves in the Port Stanley/Crab Bay area

compiled digitally by Vanuatu's Forestry Dept, which was lost due to hardware failure), whilst other data do not make differentiation between mangrove species possible, thus limiting their value and use (Molu Bulu MESCAL pers.com. 2013). Accordingly areas that have been the focus of MESCAL demonstration sites (Figure 2) are now increasingly better mapped, whereas areas of mangroves on other islands are still somewhat less well understood.

From the mangrove species perspective there is more clarity. In Vanuatu, thirteen major mangrove

tree species have been recorded (Macnae, 1968) in eight families. Typically, there are four recognizable zones: a landward fringe now generally cleared by human activity, thickets of *Ceriops tagal* with the mangrove fern *Acrostichum aureum*, a *Rhizophora* forest zone, and a seaward zone of *Avicennia marina*, occasionally with scattered *Sonneratia caeseolaris* and *Bruguiera* (Bani and Esrom 1993). In some localities, the stands of *Sonneratia* and *Bruguiera* comprise a further recognizable zone (Chambers, 1988).

## 5. Vanuatu blue carbon preparedness

Such is the importance of mangroves that sustaining the associated values is worth promoting and pursuing in its own right, irrespective of whether or not it is possible to generate carbon credits from the stored carbon reserves.

On the basis of the level of knowledge of blue carbon systems in Vanuatu, it is important to assess Vanuatu's current state of preparedness to undertake blue carbon work. This has been assessed through a combination of the field visit, meeting with various stakeholders in Vanuatu, associated desktop analysis of available information sources, and conversations with experts on different aspects of blue carbon. This preparedness assessment has been made from a number of perspectives:

- *The level of stakeholder/community support and values attached to mangroves and their management;*
- *The amount of information available on the mangrove resource on which to build a blue carbon project;*
- *The level of support and interest at the Governmental level to provide leadership for a blue carbon project; and*
- *The level of analysis of policy and legislation and awareness of opportunities and shortcoming from which to provide a solid institutional framework for implementation.*

From the community/stakeholder standpoint mangroves in Vanuatu, as in other countries of the South Pacific, are an important source of fuel wood, building materials, medicine, food, and are critical components of subsistence fisheries (Figure 4 a – c). The overall impacts of communities on mangroves still appears to be relatively low and mainly limited to subsistence activities such as collection of food, firewood and building materials. Whilst it is theoretically possible to licence the logging of mangroves, none is known to occur or be approved at the current time. There has, however, been some

clearing of mangroves for village construction and development, including small resorts, such as near Port Villa (Figure 4 d), and access points for launching boats and jetties, for example near Port Villa and also in Malekula. In the Port Vila area,

### Eight leading characteristics that an effective blue carbon project in the Pacific region would display:

- Strong emphasis, connections, support and engagement with local communities throughout
- Clarity and respect of customary law stewardship as applied to blue carbon
- Clear legislation and policies on blue carbon in support of community stewardship
- A large area of blue carbon habitat, perhaps combined with a terrestrial REDD+ project
- Recent and accurate mapping and carbon content data available for the blue carbon ecosystem
- A clear understanding and quantification of associated socio economic conditions
- Strong government leadership
- Sustainable financing to make the necessary investments in capacity, manpower and knowledge

tourist developments have involved the removal of 10 ha of mangroves (Chambers, 1988; Lal & Esrom, 1990). Agriculture has and may still be putting pressure on the landward edges of mangrove stands, for example, for coconut plantations. The value and importance of mangroves is recognised but new actions are needed at all levels, from the community through to government policies and practices, if small-scale losses are not to continue or grow in the future as overall pressures from the population increase. Such is the importance of mangroves that sustaining the associated values is worth promoting and pursuing in its own right, irrespective of whether or not it is possible to generate carbon credits from the stored carbon reserves.

Traditional values and uses centred on mangroves remain strongly apparent at the community level; although their survival is likely to be linked less to direct values than to the changing circumstances and pressures communities, especially on islands, find themselves. This is due to more fundamental issues such as sustaining supplies of freshwater, and hence the very fabric of villages, in the face of problems around saline intrusion into groundwater supplies. Actions are currently taken, for example, to manage use and access to mangrove resources through traditional community management and tenure systems. This includes the use of wood for local building and access to natural resources held by mangroves through, for example, managing crab removal for food, and access to the resource as a

whole by village chiefs decreeing some areas for complete protection.

When the issue of blue carbon was discussed with community and village leaders, few had previously thought of the role mangroves or seagrass meadows play in carbon sequestration. They immediately considered how this could bring elevated recognition of the importance of their role in good stewardship of the mangroves and natural resources. It would allow local actions to be more directly linked to national, regional and global agendas of mitigating and adapting to climate change. This context provides a fundamental basis from which to develop a blue carbon project, recognising and integrating the wider community perspective and values alongside any new values blue carbon can offer. Continued discussions with community leaders and village elders will be important to develop this perspective and to empower them through practical involvement in any future projects that focus on the blue carbon aspects of mangrove and seagrass ecosystems.

From the natural resource perspective, and whether enough is known to proceed with a blue carbon initiative, there are several levels to the response that can be given. At the most basic level the presence of these habitats and their associated generic values for carbon, biodiversity, and ecosystem good and services should be sufficient to trigger particular responses through policies and action (see section 6). At a more



**Figure 4.**

Examples of positive values and uses ((a) as a building material, (b) for roofing, and (c) for food) and negative impacts ((d) mangrove clearance for resorts) on Vanuatu's mangroves.

quantified level, projects such as MESCAL, the REDD+ readiness work undertaken across the Pacific region (e.g. Vickers, Ogle and Speigth 2011), and activities in Vanuatu, such as the REDD+ preparatory actions (e.g. Pineda 2011, Seifert-Granzin 2012), and through the Forest Department, are leading examples of how existing initiatives provides a good basis to proceed. New initiatives, such as the regional cooperation project in the South Pacific 'RESCUE', which is being designed to develop or maintain the ecosystem services that coastal, land and marine environments provide so as to strengthen communities' capacities and capabilities to adapt to climate change, may also be of relevance and help.

Mangroves are part of the Readiness Preparation Proposal (R-PP) submitted to the Forest Carbon Partnership Facility (FCPF)<sup>15</sup>. A more thorough analysis of the RPP is needed to evaluate the additional work needed to insure that mangroves are properly included into REDD. Efforts should be undertaken to ensure that the national REDD+ strategy, and related monitoring and MRV systems will include relevant mangrove data and information.

Further evolution of policies and legislation is required to best enable rights and responsibilities for the blue carbon resource, and to ensure that such values are readily addressed through customary tenure, land use planning and management systems, including environmental impact assessments.

If, however, the goal becomes one of monetising the financial value of the stored carbon, then significant gaps in understanding of the resource and in the policy and legal framework need to be closed. As discussed earlier, focussing solely on this aspect would be a high risk strategy and probably dysfunctional without careful planning from a community perspective given the challenges around the mismatch between customary land

stewardship and common law rights on which legislation tends to operate. It should also be borne in mind in that context that Vanuatu has only limited stands of mangroves with variable depths of sediment (Figure 5). So the heightened importance of mangroves through blue carbon will not so much reside in financially incentivising the stored carbon as in the overall suite of goods and services blue carbon habitats provide, and which can be used to highlight and champion wise community use.

For seagrasses, as has been stated earlier, there is much less information and hence the basis from which to realise any blue carbon potential is weaker. This is not to say that, as with mangroves, action should not be taken in the short term to best protect and manage this habitat given the considerable ecosystem goods and services it provides, but much more work will be needed to include seagrasses in a future blue carbon project. The Voluntary Carbon Standard now allows for seagrasses but measurements and planning have yet to be brought together to support this reality. In view of the lack of information on seagrass meadows, focussed and significant work to address this aspect of blue carbon in Vanuatu might be usefully taken up through future work, perhaps through the mechanism of an Ocean Summit, modelled on the recent Lands Summit that has been a major stimulus in developing governance, stewardship, policy and legislation for terrestrial areas.

One of the most significant gaps for mangroves is that no carbon content analysis has yet been undertaken for above or below ground biomass and sediment content in Vanuatu. Knowing not only precise areas of mangroves but also how much carbon they contain are essential prerequisites in determining the size of the carbon sink that Vanuatu's mangroves represent. Observations from the February field trip associated with this study suggest that quantities of sequestered carbon may vary considerably depending on the location of the mangrove stands. Mangrove stands in bays appear to hold considerable carbon trapped in the soft extensive sediment, whilst those on more exposed headlands can grow on old coral reef platforms with apparently limited carbon sequestration opportunity (Figure 5). With the good basis provided by the results of existing work, closing such gaps using a focussed and well designed carbon resource evaluation project would be possible.

From the governmental angle blue carbon is a natural choice to champion for Vanuatu.

<sup>15</sup> <http://www.forestcarbonpartnership.org/sites/fcp/files/2013/Vanuatu%202012-02-26%20R-PP-final.pdf>



**Figure 5.** Mangrove stands on Malekula showing differences in underlying substrate and hence carbon sequestration and sink potential – deep sediment system (left) and mangroves growing on ancient coral platform with little sediment (right).

Being a country composed of islands with the community's close associations to the sea, but also one assessed as being of the greatest exposure to natural risks, it is important to maximise the contribution natural ecosystems can bring to the nation's overall wellbeing. Thus having blue carbon habitats present and mainly in a natural state provides an excellent basis to proceed with blue carbon work. This is especially the case given previous work that provides, at least for mangroves, a good understanding of the resource and issues on which to base future work. The fact that Vanuatu has already become the regional leader on promoting blue carbon both within the region, and to international fora such as Rio + 20, demonstrates the high level of political commitment to recognise blue carbon and follow through on future actions.

Finally, from a policy and legislative perspective, blue carbon provides further incentives to develop the existing frameworks and build forward-looking approaches that benefit local communities and

the future status and health of such ecosystems. Recognising blue carbon is a natural fit to the processes still evolving since independence in 1980 to grow community customary rights systems and management, and recognise and empower tradition and sustainable activities as part of growing the low carbon economy. Recent activities such as the Lands Summit as well as recent evaluations of the policy and legislative framework for REDD+ implementation, once again provide a good basis to proceed.

Clarity on who is responsible for the blue carbon within the new constitutional arrangements is needed to proceed. It is evident from this work that further evolution of policies and legislation is required to best enable rights and responsibilities for the blue carbon resource, and to ensure that such values are readily addressed through customary tenure, land use planning and management systems, including environmental impact assessments.

## 6. Benefits of recognising the value of blue carbon

In the long-term there will undoubtedly be financial incentives if not broader opportunities to protect and sustainably manage all blue carbon ecosystems as part of wider climate change adaptation and mitigation strategies with a core focus on communities and stewardship.

If the working assumption is that this is an opportune moment and it is a practical proposition for Vanuatu to embrace blue carbon, what could the advantages be of recognising the true value of these coastal carbon sinks? The benefits predominantly fall into two areas:

1. The direct benefits to communities and Vanuatu as a whole; and
2. The indirect benefits to communities, Vanuatu and the region.



In relation to direct benefits derived from better embracing blue carbon values, several aspects are very evident from discussions in Vanuatu, the arguments previously set out in this report, and wider global experiences:

#### *Promoting wise and sustainable use*

The first is that simply promoting the wise and sustainable use of these habitats aligns well with the low carbon economy approach and the community customary stewardship arrangements that already exist in Vanuatu. Recognising and promoting wise use, and educating and involving stakeholders and villages on blue carbon is an investment in the future, by investing in the natural capital that continues to support and underpin community life. Not to do so would be to lose many values that support communities throughout the island group.

#### *Delivering more sustainable land use planning decisions*

Second is that from a policy and legislative perspective, acknowledging and quantifying blue carbon could lead to a greater shared understanding and recognition of the 'true' value that these ecosystems represent to society. Seeing these values set out would be important to help better shape overall land use management and the decisions and frameworks that necessarily accompany such processes. In particular the value of blue carbon in these ecosystems should be fully built into development processes and environmental impact assessments. This should be to the degree that maintaining and sustaining these ecosystems (and therefore the support they provide communities) is the default policy position. Thus the direct benefit would be to favour communities, to favour sustaining tradition, to favour low emissions, and to favour sustainable living, and be against continued piecemeal habitat destruction that would simply increase Vanuatu's already high exposure to natural risk. The consequence would be to better locate activities and developments that are incompatible with sustaining mangroves and blue carbon to other areas, and thereby not necessarily impeding economic development or growth, but nevertheless securing the very real benefits for the community into the future.

#### *Building governance systems*

Third is that embracing blue carbon will help drive reforms and governance developments already in motion to greater and beneficial conclusions.

Intimate relationships already exist between communities and their surrounding environment. Better recognition of blue carbon and the role local communities play through wise use needs to be built into the continued evolution of governance post independence. It provides opportunity and reason to further clarify governance processes, especially around customary land stewardship and managements, and particularly what happens and needs to happen at the coast and in shallow coastal waters, on which many other issues of importance also depend, such as fisheries, and coastal management and development.

#### *Delivering climate change adaptation and mitigation*

A fourth aspect is the opportunity and benefit that better managing blue carbon holds for Vanuatu, the region and the world. Given the dispersed nature of coastal carbon sinks, they infer responsibilities on many coastal countries to better manage their marine environments for real benefits. If we are to limit carbon dioxide emissions from natural systems, it is the responsibility of all nations to act, because for blue carbon no one nation holds the solution. Alongside the political opportunities that blue carbon offers, it also provides direct benefits to Vanuatu in both playing its part on the global stage to limit emissions of carbon dioxide from natural systems, and also in trying to retain these ecosystems to limit their own not inconsiderable exposure to natural risks. These risks may be the buffering that natural ecosystems provide to cyclones and tsunamis, but also more localised risks stemming from poor management of local resources and the need to ensure and maximise regenerative abilities of the environment to support villages and local communities dependent on such resources in the future.

#### *Providing the basis for possible future new 'natural' economic drivers*

A fifth and final benefit may, in the long term, be from realising the financial potential that the volume of stored carbon in these habitats could represent in Vanuatu. This benefit is cautiously promoted here as it is a much longer-term benefit to realise than the others listed above, which could all be achieved in the shorter-term. At the present time the amount of carbon, and hence possible financial capital, is unknown and because, whilst present, the areas of mangroves and seagrass meadows in Vanuatu are relatively small compared to areas elsewhere in the region and around the

world. Caution is therefore needed on this issue and also because of the mismatch between customary land stewardship and definition of common law rights needed to quantify ownership in legislative systems.

Generally the condition of mangroves and seagrass meadows in Vanuatu is good compared to areas in other countries, and not significantly subject yet to piecemeal losses. There is therefore less apparent upfront opportunity to invest against ongoing losses, or to attract investment capital to restore large already degraded areas with replanting, if that is one of the routes explored. REDD+ already includes mangroves so alternative opportunities should be considered of undertaking mangrove carbon projects through terrestrial forest REDD+ work to overcome issues of scale if other challenges could be overcome as well. There is specific work that would need to be undertaken to realise such carbon values, which could form the heart of a future blue carbon project, but this will take time to achieve. The work required is set out later in this report.

In the long-term there will undoubtedly be financial incentives if not broader opportunities to protect and sustainably manage all blue carbon ecosystems as part of wider climate change

adaptation and mitigation strategies with a core focus on communities and stewardship. Donors may have an interest in supporting the community perspective around blue carbon, livelihoods and wellbeing. Positioning Vanuatu to benefit from such opportunities would be a prudent move at this time if the supporting finance can be found.

The more indirect benefits from blue carbon follow very much from the potential direct benefit areas summarised above. Clearly following through on fully implementing blue carbon work in the broadest sense as described here will help to continue to consolidate Vanuatu's existing political leadership regionally and globally on such issues. Recognition of blue carbon will also help strengthen and develop future ideas around the scope and nature of Vanuatu's future ocean policy and actions surrounding its extended continental shelf. Finally embracing blue carbon plays directly into the low carbon economy approach evident in Vanuatu. It could have considerable benefits to help support future eco-tourism and its marketing, if this was directed at small-scale, high-end, high-value, high-user-experience ecotourism that would be synonymous with the unspoilt beauty and natural assets of the country.

## 7. Barriers to implementation of blue carbon in Vanuatu

Whilst this report shows the potential direct and indirect benefits that blue carbon could bring to Vanuatu, there are also a number of barriers that would need to be overcome to achieve implementation. Most have been touched on earlier in this report but for clarity are summarised below:

### *Tenure and ownership*

Whilst processes continue to develop and strengthen on land post independence, customary land stewardship is still uncertain or ill-defined in coastal and particularly nearshore areas where both blue carbon ecosystem occur. Further clarification is needed on responsibility for stewardship, management and decision making for these habitats.

### *State of knowledge*

Accurate mapping for mangroves is incomplete and no area mapping is available for seagrass meadows. Mangroves would be the easiest to deliver accurate mapping of total extent and major species composition. Carbon content analysis is also required to calculate the scale of the carbon contained in the system (see Annex 5). A good understanding of the socio-economic conditions associated with blue carbon is also required. Work is underway on this topic through MESCAL though it is unclear how far this goes to provide the entire perspectives needed. Recent work in the Solomon Islands on blue carbon socio economics is a good example to explore (Albert et al 2012), as it demonstrates the value of quantifying importance



## Proposals to address current shortcomings in Vanuatu's existing carbon framework that may help support blue carbon activities:

- Introduce a comprehensive definition of forest carbon rights that is linked to land 'ownership' and applies to all lands
- Amend the standard form of lease to make it clear that a lessee is entitled to sell the verified emission reductions and removals from leased land
- Decide and define the most appropriate form of landowner association to hold and manage the exercise of carbon rights in REDD+ projects
- Decide and define the most appropriate place for registering REDD+ projects and approvals

Derived from Corrin (2012).

in terms of household incomes, as well as scales of piecemeal losses, for example, from the collection of mangrove wood for firewood.

### *Scale of the resource*

Only limited areas of mangroves and seagrass meadows occur in Vanuatu. They are small within the context of the region and areas elsewhere around the world. They are clearly viable units which are 'investable' from the community/village perspective but it is unclear how 'investable' such limited areas would be from traditional carbon financing perspectives. Lower transaction costs and higher feasibility to generate carbon credits are usually associated with much greater areas of (blue) carbon habitats, and greater trends in loss, where investment can be made to avoid losses across a much greater scale. An alternative and potentially more attractive strategy would be to consider implementation through combining mangrove carbon with an existing or terrestrial forest REDD+ project for Vanuatu, if the associated challenges described in this report can be overcome.

### *Legislation and stewardship*

The current legal framework requires further development to allow for implementation of blue carbon. It is either not defined or ill defined and details of customary law stewardship and who would be responsible for the blue carbon 'asset' is lacking. All such areas would need clarifying to provide a robust framework within which to fully implement any blue carbon project. Work on

REDD+ and carbon rights has already identified priority areas for action – with the assumption such changes would need to accompany a strengthening in customary law stewardship and clarity of roles and responsibilities.

### *Policy*

The supporting policies are either not fully formed (as per the problems with legislation and stewardship) or existing policies are poorly implemented. This has resulted in the piecemeal loss of mangrove areas, or unclear actions and responsibilities e.g. for seagrass meadows. Where frameworks exist, the needs of blue carbon ecosystems should be more explicitly embraced in subsequent decision making.

### *Low priority*

The final potential barrier is the lack of priority within the government and community for blue carbon, resulting in inaction and continued loss of habitat and erosion of community values associated with the resource due to other greater pressures. The degree to which this problem occurs is probably inversely correlated to how well the case is made on added values and how well communication and outreach conversations occur at all levels within the community.

Financing is also another consideration that would need to be addressed, as overcoming any of the six potential barriers to progress set out above would have financial implications to some degree.

## 8. Opportunities for fast-track implementation

The development of a bespoke broad-scale blue carbon implementation project for either Vanuatu or a greater regional grouping of nations could be undertaken as a natural progression of the MESCAL project.

In contrast to barriers to implementation, there are also useful opportunities that could be explored to support early implementation, and certainly the development of a bespoke broad-scale blue carbon implementation project for either Vanuatu or a greater regional grouping of nations. This could be undertaken as a natural progression of the MESCAL project:

### *Regional working*

The Melanesian Spearhead Group provides a good platform for inter-regional cooperation on which

to plan more specific blue carbon activities. Given the limited scale of blue carbon in Vanuatu, working through this group to look to implementation may provide economic benefits and economies of scale. The Pacific Regional Environment Programme also provides a fundamental platform to explore cooperative research and funding opportunities with many ongoing and relevant activities. This report may help inform and evolve their ideas and thinking.



### *Financial support*

Significant financial support is present within the region for climate change adaptation and mitigation activities, alongside social local community and educational activities from major donors. Some such as AusAID are already active within Vanuatu, so exploring synergies and complementary activities may provide funding opportunities to progress the blue carbon aspects as part of overall coastal sustainability and broader socio-economic initiatives. Other donors, such as the MacArthur Foundation, have been active on similar issues elsewhere in the region (Jennifer Corrin pers.comm. 2013).

In the longer-term considering Blue Carbon in the broader context of terrestrial REDD+ projects might help overcome issues around the small scale of blue carbon resources in Vanuatu and support

greater investment opportunities. Initially targeting any actions to realise financial opportunities centered on the mangrove carbon to the voluntary market opportunities may also assist early actions in this area, with longer-term focus on selling to the regulatory compliance market as frameworks mature enough to explore the practicalities of this route.

### *International science and policy capacity*

Considerable investments in science and policy have been made at the global and regional scales in the last few years to develop the potential of coastal carbon sinks. Opportunities should be taken to tap into the networks of experts and information that already exist to fast-track capacity development and knowledge exchange. Some key examples are highlighted in Annex 3.

## 9. Next steps

---

In order to develop a blue carbon project a number of actions would need to be taken to build on existing opportunities, and to provide the type of implementation and supportive policy and legal frameworks that would be needed. These actions fall into three main areas:

1. *Strengthening the knowledge base.* The following activities are needed to provide the information base to implement a blue carbon project:

- completing the accurate mapping and inventory of mangroves started by MESCAL;
- undertaking mapping of the seagrass meadows;
- undertaking carbon content analysis for mangroves and seagrass meadows to quantify scale and variability of these coastal carbon sinks; and
- completing as needed work started by MESCAL on socio-economics associated with mangroves and seagrass meadows to provide a full quantification of the ecosystem goods and services provided by these habitats alongside quantified carbon content.

It is suggested that if financial resources are limited the priority for early implementation should be on mangroves - further work at the global scale is needed globally to quantify the magnitude of emissions from near-shore marine ecosystems such as seagrass meadows. It is, however, clear that improved management of these systems would slow or reverse ongoing loss of carbon sequestration capacity.

2. *Strengthening the legal and policy framework.*

The following activities are needed to provide the legal and policy framework for a blue carbon project: (1) inclusion of blue carbon and explicitly the carbon resource they represent in relevant legislative and policy frameworks. At present

this is not fully defined resulting in a lack of clarity and uncertainty surrounding ownership and responsibility; (2) continued implementation of governance frameworks to better quantify ownership and traditional rights at the coast stemming from independence – building on the work of the Land Summit and extending that approach into coastal and nearshore areas – perhaps through an ‘Ocean Summit’; (3) explicit recognition of blue carbon and the sinks it represents in policy implementation and management approaches, such as in EIAs to ensure that decisions are taken in full knowledge of the true value and importance of these coastal habitats (such action is needed to boost protection of these critical habitats and stem the piecemeal losses currently being observed to occur which are significant at the scale of the total blue carbon resources in Vanuatu); and (4) sustained actions around outreach, education and conversations with local communities to build understanding, responsibilities and practical programme of activities to best manage and protect the blue carbon resources.

3. *Strengthening international and regional partnerships and cooperation.*

This is an important area both politically and economically. Key activities would include: (1) continued regional engagement on blue carbon which will sustain and build Vanuatu’s leadership role in the area; and (2) significant opportunities exist to benefit from investments made on blue carbon elsewhere, both by partnering with implementation initiatives ongoing in other countries but also by drawing from the pool of experience and expertise present at the global scale. A quick and practical way forward would be to link to work on blue carbon being undertaken elsewhere in the region (via the MSG), and by making direct links to researchers and experts on the east coast of Australia listed in Annex 3.

# 10. Recommendations

---

**Recommendation 1:** Complete the accurate mapping and inventory of mangroves started by MESCAL.

**Recommendation 2:** Undertake mapping of the seagrass meadows.

**Recommendation 3:** Undertake carbon content analysis for mangroves and seagrass meadows to quantify scale and variability of these coastal carbon sinks.

**Recommendation 4:** Complete (as needed) work started by MESCAL on socio economics associated with mangroves and seagrass meadows to provide a full quantification of the ecosystem goods and services provided by these habitats.

**Recommendation 5:** Clarify customary rights and practice related to stewardship, and review and amend as necessary legislation and policy frameworks to include blue carbon.

**Recommendation 6:** Continue to develop and extend governance frameworks to the coast and nearshore areas to best define carbon responsibilities and ownership by communities and government, perhaps through convening an 'Ocean Summit'.

**Recommendation 7:** Ensure that current policy and management approaches include blue carbon, especially land use planning and environmental impact assessments.

**Recommendation 8:** Undertake sustained actions around outreach, education and conversations with local communities to build understanding, responsibilities and practical programme of activities to best manage and protect the blue carbon resources.

**Recommendation 9:** Continue to grow regional political cooperation to build opportunities to implement blue carbon in Vanuatu and countries in the region.

**Recommendation 10:** Open dialogues with donors, particularly those active in Vanuatu (e.g. AusAID) or in the region, to explore funding opportunities and complementarities to existing donor initiatives.

**Recommendation 11:** Partner blue carbon work in Vanuatu with similar initiatives in other countries in the region to accelerate progress and build capacity and expertise, and consider combining with REDD+ activities already underway in so doing.

**Recommendation 12:** Engage with international work on blue carbon science and policy to draw in knowledge and expertise, either directly or through regional working.

# 11. Conclusions

**The benefits that blue carbon could bring range from the shorter-term and relatively easier to fix opportunities to better embrace this issue in day-to-day decision making and build the carbon stewardship of local communities, to the more expensive and longer-term goals of possibly capitalising on the financial value of the stored carbon.**

---

Blue carbon represents a new opportunity for Vanuatu. The benefits could be far wider than perhaps originally envisaged with a single focus on financially incentivising the value of the stored carbon alone. Indeed the conclusion of this study is that the overall package of benefits is far wider than the notion of 'carbon credits' and indeed early action would be much more beneficially spent on the wider suite of benefits, whilst working cautiously towards this longer-term goal.

The benefits that blue carbon could bring range from the shorter-term and relatively easier to fix opportunities to better embrace this issue in day-to-day decision making and build the carbon stewardship of local communities, to the more expensive and longer-term goals of possibly capitalising on the financial value of the stored carbon. As discussed in this report this longer-term goal will always remain of lower value than elsewhere due to the limited scale of blue carbon habitat present in Vanuatu, unless perhaps joined with terrestrial REDD+ actions. Even so it should not be seen to detract from an overall positive opportunity based around the fuller range of potential benefits.

Given the current political, governance and customary stewardship arrangements in Vanuatu this broader range of possible benefits match

well to the current situation and could help enhance and inform a number of activities already underway. It seems probable that recognition of blue carbon and particularly the stewardship of the resource by villages, communities and local stakeholders would help at least to contribute to efforts to sustain the traditions and customs that are under threat from a variety of other modern day pressures.

Clearly any and all actions to act on blue carbon in Vanuatu will address multiple goals. It would clearly help support local villages and communities through wise customary stewardship of their local resources; it would be in sympathy with the low carbon economy approach being pursued by the Government of Vanuatu; it would sustain biodiversity and associated ecosystem goods and services; and it could be a major part of climate change adaptation and mitigation activities at the national and regional scale.

As we look towards an increasingly uncertain climate future, any and all actions to work with nature, to benefit from nature's abilities to buffer from extreme events such as tsunamis and cyclones, and to ensure we don't inadvertently destroy carbon sinks built up over millennia has to be a positive agenda and one in which Vanuatu can play an important role as a key champion.

## 12. Glossary

---

**Adaptation** In the specific context of climate change, adaptation means adjusting to a new set of climatic attributes, either new or unfamiliar from those already existing, or changed parameters of existing attributes. This adjustment can be imposed based on premeditated planning, or it can take place without specific policy frameworks to implement it (i.e. autonomous adaptation).

**Blue Carbon** The carbon stored, sequestered or released from coastal ecosystems of tidal marshes, mangroves and seagrass meadows. The term does not refer to carbon stored, sequestered or released by the open ocean and closely related ecosystems and organisms.

**Blue Carbon activities** This refers to a suite of sustainable policy, management and planning activities in coastal ecosystems to reduce emissions from conversion and degradation and to conserve and sustainably manage coastal carbon sinks.

**Carbon sequestration** Carbon sequestration is the process of capture and long-term storage of atmospheric carbon dioxide (CO<sub>2</sub>)

**Coastal carbon sinks** Another name for Blue Carbon – the carbon stored, sequestered or released from coastal ecosystems of tidal marshes, mangroves and seagrass meadows.

**Greenhouse gas** A greenhouse gas (sometimes abbreviated to GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect which raises the global temperature. The primary greenhouse gases in the Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

**Ecosystem** A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Article 2 of the Convention of Biological Diversity).

**Ecosystem-based adaptation** The use of biodiversity and ecosystem services as part of an overall adaptation strategy to the adverse effects of climate change

**Ecosystem services** The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating

services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.

**Leakage** The general meaning of a carbon leakage corresponds to "*the ratio of carbon emissions from a specific sector outside the country (as a result of a policy affecting that sector in the country) over the carbon emission reductions in the sector (again, as a result of the environmental policy)*". The definition of "carbon leakage" in the UNFCCC-related literature can be "strong" or "weak" depending if the reference is directly to emissions (strong) or to emissions embodied in imports (weak).

**Mitigation** Climate change mitigation is action to limit the magnitude and/or rate of long-term climate change. Climate change mitigation generally involves reductions in human (anthropogenic) emissions of greenhouse gases (GHGs). Mitigation may also be achieved by increasing the capacity of carbon sinks, e.g., through reforestation. By contrast, adaptation to global warming are actions taken to manage the eventual (or unavoidable) impacts of global warming, e.g., by building dikes in response to sea level rise.

**Permanence** Ensures that the project's carbon dioxide (CO<sub>2</sub>) benefit is either avoided as an emission or sequestered or stored and stays out of the atmosphere for a "long-enough" time to meet the climate change mitigation project's objective. The definitions for "long-enough" vary – forever, 100 years, or over the commitment period for reducing or offsetting CO<sub>2</sub> emissions.

**Sustainable development** The type of development that improves the welfare of people at the present time without compromising that of future generations.

**Traditional governance structure** Social organisation and hierarchy of power and authority by which communities are governed including traditional social control mechanisms.

**Traditional knowledge** Indigenous/traditional knowledge based on long-standing traditions and practices of local communities.

# 13. References

- Albert, J.A, Warren-Rhodes, K, Schwarz, A.J and N.D. Duke. 2012. *Mangrove Ecosystem Services & Payments for Blue Carbon in Solomon Islands*, The WorldFish Center, Solomon Islands. AAS-2012-06.
- Bani, E, and D. Esrom. 1993. 'Republic of Vanuatu'. 18pp. In: Scott, D.A (1993). *IUCN Directory of Wetlands in Oceania*. Ramsar Bureau, International Waterfowl and Wetlands Research Bureau (IWRB), Asian Wetland Bureau (AWB) and the South Pacific Regional Environment Programme (SPREP).
- CEC, 2012. *Guide for Planners and Managers to Design Resilient Marine Protected Area Networks in a Changing Climate*. Montreal, Canada. Commission for Environmental Cooperation. 42 pp.
- Chambers, M.R. 1988. *The Mangroves of Vanuatu. Information Note for the Working Group Meeting for the Rational Use of Mangroves in the Pacific Island Region*, Apia, Western Samoa, February 1988.
- Chambers MR, Nguyen F and Navin KF. 1990 'Seagrass communities', pp. 92-103. In: Done TJ and Navin KF (eds) *Vanuatu Marine Resources: Report of a biological survey*. Australian Institute of Marine Science. 272 p.
- Corrin, J., 2012. *Analysis of REDD+ and forest carbon rights. International Climate Initiative*. Regional project Climate Protection through Forest Conservation in Pacific Island Countries. SPC / GIZ Regional REDD+ Project. 84pp.
- Duarte, C.M., Middelburg, J.J., Caraco, N. 2005. 'Major Role of Marine Vegetation on the Oceanic Carbon Cycle'. *Biogeosciences* 2:1-8.
- Kushner, B, Waite, R., Jungwiwattanaporn, and L. Burke. 2012. *Influence of coastal economic valuations in the Caribbean: enabling conditions and lessons learned*. Working paper. Washington DC: World Resources Institute. Available at <http://www.wri.org/coastal.capital>
- Herr, D. Pidgeon, E. and D. Laffoley. (eds.) (2012). *Blue Carbon Policy Framework: Based on the discussion of the International Blue Carbon Policy Working Group*. Gland, Switzerland: IUCN and Arlington, USA: CI. vi+39pp.
- Laffoley, D. d.A. 2012. *A new approach to ocean governance: Practical ways to fast track the Green Economy*. Commonwealth Consultative Group on Environment, Nairobi, February 2012. A Paper by the Commonwealth Secretariat. 20 pp.
- Laffoley, D. & Grimsditch, G. (Eds.) 2009. *The Management of Natural Coastal Carbon Sinks*. IUCN, Gland, Switzerland, 53pp. [http://cmsdata.iucn.org/downloads/carbon\\_management\\_report\\_final\\_printed\\_version.pdf](http://cmsdata.iucn.org/downloads/carbon_management_report_final_printed_version.pdf)
- Lal, P.N. and D.K Esrom. 1990. 'Utilisation and Management of Mangrove ('Narong') Resources in Vanuatu'. Unpublished report. As cited in: Bani, E, and D. Esrom. 1993. Republic of Vanuatu. 18pp. In: Scott, D.A (1993). *IUCN Directory of Wetlands in Oceania*. Ramsar Bureau, International Waterfowl and Wetlands Research Bureau (IWRB), Asian Wetland Bureau (AWB) and the South Pacific Regional Environment Programme (SPREP).
- Lang, C. 2012. *Problems with REDD and payments for environment services in Acre, Brazil*. <http://www.redd-monitor.org/2012/11/01/problems-with-redd-and-payments-for-environment-services-in-acre-brazil/>
- Macnae, W. 1968. 'A general account of the fauna and flora of mangrove swamps and forests in the Indo-West Pacific Region'. *Advances in Marine Biology* 6: 73-270.
- Munang, R, Thiaw, I., Alverson, K., Mumba, M., Liu, J., and M. Rivington. 2013. 'Climate change and ecosystem-based adaptation: a new pragmatic approach to buffering climate change impacts'. *Current Opinion in Environmental Sustainability*, 5: 1-5.
- Nellemann, C., Corcoran, E., Duarte, C. M., Valdes, L., De Young, C., Fonseca, L., Grimsditch, G. (Eds). 2009. *Blue Carbon. A Rapid Response Assessment*. United Nations Environment Programme, GRIDArendal, <http://www.grida.no/publications/rr/bluecarbon/>
- McIvor, A., Spencer, T., Moller, I., and S. Spalding. 2012. 'Storm surge reduction by mangroves. Natural Coastal Protection Series: report 2'. *Cambridge Coastal Research Unit Working Paper 41*.
- Mucke, P. World Risk Report 2012. Alliance Development Works, Berlin.
- Pacific Islands Forum, 2012. *Pacific Plan 2012. Annual Progress report*. Pacific Islands Forum Secretariat. 20 pp.

- Philips Williams & Associates (PWA), Ltd & Science Applications International Corporation (SAIC). 2009. *Greenhouse Gas Mitigation Typology Issues Paper Tidal Wetlands Restoration*. Prepared for California Climate Action Registry. [http://www.climateactionreserve.org/wp-content/uploads/2009/03/future-protocoldevelopment\\_tidal-wetlands.pdf](http://www.climateactionreserve.org/wp-content/uploads/2009/03/future-protocoldevelopment_tidal-wetlands.pdf)
- Pineda, R. 2011. *Vanuatu REDD+ Demonstration Activities. Participatory Pilot Site Demarcation and Description*. International Climate Initiative. Regional project Climate Protection through Forest Conservation in Pacific Island Countries. SPC / GIZ Regional REDD+ Project. 33pp.
- Seifert-Granzin, J. 2012. *Methodology development for MRV and Reference Level for REDD+ in Vanuatu*. Regional project Climate Protection through Forest Conservation in Pacific Island Countries. SPC / GIZ Regional REDD+ Project. 27pp.
- Spalding, M., Kainuma, M., & L. Collins. (2010) *World atlas of mangroves*. ITTO, ISME, FAO, UNEP-WCMC, UNESCO-MAB and UNU-INWEH. Earthscan UK, USA.
- The World Bank, 2010a. *World Development Report 2010: Development and Climate Change*. The International Bank for Reconstruction and Development: Washington, D.C.
- The World Bank 2010b. *Convenient Solutions to an Inconvenient Truth: Ecosystem-Based Approaches to Climate Change*. The International Bank for Reconstruction and Development: Washington, D.C.
- Vickers, B., Ogle, L., and N. Speigth. 2011. *Regional REDD+ Readiness Support Strategy of the Pacific*. UN-REDD Programme. 96 pp.
- Waycott, M., Duarte, C. M., Carruthers, T. J. B., Orth, R. J., Dennison, W. C., Olyarnik, S., Calladine, A. Fourqurean, J. W., Heck, Jr., K. L., Hughes, A. R., Kendrick, G. A., Kenworthy, W. J., Short, F. T., and S. L. Williams. 2009. 'Accelerating loss of seagrasses across the globe threatens coastal ecosystems'. *Proceedings of the National Academy of Sciences*, 106 (doi:10.1073.pnas.0905620106)

# ANNEX 1.

## National and regional climate change adaptation and mitigation programmes, projects and initiatives relevant to blue carbon, and selected international online resources on blue carbon

---

There are a number of programmes, projects and initiatives within the region that are of particular relevance to blue carbon considerations in Vanuatu. Brief notes and web links of illustrative examples are provided below to promote cooperation and shared capacity development, but the list below does not attempt to be comprehensive.

**National Adaptation Programmes of Action (NAPA).** Under the United Nations Framework Convention on Climate Change (UNFCCC) it was agreed that Least Developed Countries (LDC's) would be supported to develop National Adaptation Programmes of Action (NAPA's). NAPA's were intended as a way for LDC to identify and prioritise their urgent adaptation needs, so that they may be funded and implemented as a priority. Priorities are identified based on existing information, and the process is very much a bottom up one, which encourages participation starting from the grass roots and community levels all the way up to national decision makers. There are five LDC's who qualify for NAPA funding and support in the Pacific: Kiribati, Samoa, Solomon Islands, Tuvalu and Vanuatu. All five of these countries have now submitted NAPAs and are now in the process of implementing those priority needs identified through the NAPA process. See for example: [http://unfccc.int/cooperation\\_support/least\\_developed\\_countries\\_portal/items/4751.php](http://unfccc.int/cooperation_support/least_developed_countries_portal/items/4751.php)

**Pacific Adaptation to Climate Change Project (PACC).** The PACC Project is designed to promote climate change adaptation as a key prerequisite to sustainable development in Pacific Island Countries. Its objective therefore is to enhance the capacity of the participating countries to adapt to climate change and climate variability, in key development sectors. The PACC project is funded by the Global Environment Facility (GEF), and further funding has been provided by the Australian Government (AusAID) and the United States of America (USAID) for additional activities, with support from UNITAR through the C3D+ programme for developing

adaptation measures and capacity building to effectively respond to climate change. It is implemented by the United Nations Development Programme (UNDP) in partnership with the Secretariat of the Pacific Regional Environment Programme (SPREP). The project is from 2009 to 2013. The PACC project covers 13 participating countries and helps develop three key areas that build resilience to climate change in Pacific communities: Fiji, Palau, Papua New Guinea and the Solomon Islands focus on Food Production and Food Security; Cook Islands, Federated States of Micronesia, Samoa, Tokelau and Vanuatu are developing Coastal Management capacity; and Nauru, Niue, Republic of Marshall Islands, Tonga and Tuvalu are looking to strengthen their water resource management. With the additional resources provided by AusAID and USAID, Kiribati and Tokelau will become participants in PACC. See for example: <http://www.sprep.org/Pacific-Adaptation-to-Climate-Change/about-pacc>

**SPC/GIZ "Climate Protection through Forest Conservation in the Pacific Islands".** Deforestation and forest degradation account for 17 per cent of global greenhouse gas emissions. Although Pacific Island Countries (PICs) contribute very little to this, the larger forested PICs can play an important role in reducing global carbon emissions. There are opportunities for these countries to benefit financially from maintaining and establishing forest areas to mitigate climate change through a REDD carbon financing mechanism. To develop regional and national policies as well as institutional capacities for the implementation of REDD+, the Land Resources Division of the Secretariat of the Pacific Community (SPC LRD) received support from Germany's International Climate Initiative (ICI) for a regional project titled 'Climate protection through forest conservation in the Pacific Island Countries'. The ICI has been financing climate protection projects of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in developing countries since

2008. This ICI-project will have a funding of EUR 4.9 million over a four-year period from November 2010 to the end of October 2014. The project will support REDD+, which includes conservation, sustainable forest management and enhancement of forest carbon stocks in addition to reducing deforestation and forest degradation. The project is implemented by GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) and has 3 components: 1. Pacific Regional REDD+ Policy Framework; 2. REDD+ Information and support platform; and 3. REDD+ readiness on national level. The regional component will cover all SPC member countries and territories, but national activities will focus on three countries with large forest cover: Papua New Guinea (PNG), Solomon Islands and Vanuatu. See for example: [http://www.spc.int/lrd/index.php?option=com\\_content&view=article&id=818&Itemid=527](http://www.spc.int/lrd/index.php?option=com_content&view=article&id=818&Itemid=527)

**MESCAL (Mangrove Ecosystems for Climate Change Adaptation and Livelihoods).** MESCAL is a project to increase the climate change resilience of Pacific Islanders as well as improve their livelihoods through selected capacity support in adaptive co-management and restoration of mangroves and associated ecosystems in five countries: Fiji, Samoa, Solomon Islands, Tonga and Vanuatu. See for example: [http://www.iucn.org/about/union/secretariat/offices/oceania/priorities/priority\\_naturebasedsolutions/water\\_wetlands/about/](http://www.iucn.org/about/union/secretariat/offices/oceania/priorities/priority_naturebasedsolutions/water_wetlands/about/)

**Mangrove ecosystem services and payments for blue carbon in Solomon Islands (MARSH).**

The AusAID Development Research Project: Poverty Alleviation, Mangrove Conservation and Climate Change: Carbon offsets as payment for mangrove ecosystem services in Solomon Islands (# 49892) was designed to evaluate the potential for mangrove carbon revenue programmes in Solomon Islands. The approach was to address three main questions: (1) How are mangrove ecosystem goods and services currently used and valued by coastal populations with a high reliance on a subsistence economy? (2) What is the total carbon stock held in mangrove ecosystems? and (3) Are carbon markets, whether compliance or voluntary, feasible options for Solomon Islands communities and government to alleviate poverty, reduce mangrove forest resource degradation and contribute to climate change adaptation and mitigation? The project was conducted through a partnership between WorldFish and the Solomon Islands Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM). See for example: <http://www.aas.cgjar.org/>

publications/mangrove-ecosystem-services-and-payments-blue-carbon-solomon-islands

**Mangrove Rehabilitation for Sustainably Managed, Healthy Forests.** The MARSH project is the United States Agency for International Development's new five-year project that seeks to restore mangrove forests in the Pacific region. The project seeks to restore mangrove forests and improve the management of forested areas in Papua New Guinea, Solomon Islands and Vanuatu. The project will work with the local governments of communities, provinces, and the national governments to provide today's leaders with the information necessary to manage their natural resources in a sustainable way, and integrate that management into effective climate change planning.

The MARSH project's main activities include: (1) providing training for community-based, sustainable mangrove forest management and mangrove reforestation; and (2) strengthening technical and scientific capacity of local universities and public institutions to conduct forest carbon monitoring, reporting and verification. In Papua New Guinea, the MARSH project will support the government in achieving the goals cited in the Papua New Guinea Vision 2050—reducing greenhouse gas emissions by 90 percent, to 1990 levels; establishing a sustainable development strategy for forests by 2015; increasing resilience to natural disasters and environmental change; and supporting the Office of Climate Change and Development's goal of planting one million mangrove trees by 2016. Actions in the Solomon Islands and Vanuatu will follow in later years of the project.

**WWF South Pacific Programme** (Lisa Ogle, pers comm. 2013) – WWF's niche in Fiji is in mangrove conservation. WWF has completed a GEF-funded project developing and testing a generalized approach for assessing vulnerability and adaptation of mangroves and coastal systems to the effects of climate change. It is working with landholders to assist them to integrate climate change adaptation strategies into their management plans. See for example - Vulnerability of Fiji's mangroves and associated coral reefs to climate change: A review by WWF South Pacific Programme, February 2010, lead author Joanna C Ellison, School of Geography, University of Tasmania.

**Australia's Coastal Carbon Cluster.** Understanding the important role of Australia's coastal and marine wetlands in storing atmospheric carbon dioxide

will be the focus of a new \$3 million collaborative research project headed by the CSIRO and eight tertiary institutions. Over three years, the Coastal Carbon Cluster will create new models to collect information on "blue carbon", a concept name for the capture and storage of atmospheric carbon in the marine environment. Australia's coast nurtures a large proportion of the world's seagrass and mangrove forests, but many of these have been damaged in the past. Conserving and restoring their coastal habitats is a cost-effective way to mitigate climate change by rebuilding carbon sinks, while delivering valuable ecosystem services to society. See for example: <http://www.news.uwa.edu.au/201302225433/climate-science/3m-project-map-australias-blue-carbon-potential>

**The Pacific Oceanscape Initiative.** Predicated on strong national leadership and regional cooperation, the Pacific Oceanscape initiative focuses urgent and timely attention on critical issues. Since endorsing the Pacific Oceanscape Framework in August 2010, 15 island nation governments, all regional intergovernmental agencies, and the conservation community have been working in cooperation to implement the Pacific Oceanscape initiative, which was first introduced in 2009 by President Anote Tong of Kiribati. The Pacific Oceanscape will expand protected areas and protected area networks that take into consideration entire archipelagos, and will foster collective effort to minimize climate change impacts. The Oceanscape will facilitate the sharing of information and lessons valuable to the sustainable management of the region's vast resources to secure Pacific Islanders' livelihoods and well-being for future generations. See for example: <http://www.conservation.org/global/marine/initiatives/oceanscapes/pages/pacific.aspx> and [http://www.sprep.org/att/publication/000937\\_684a.pdf](http://www.sprep.org/att/publication/000937_684a.pdf)

A number of online web resources exist on blue carbon that may be particularly helpful in helping inform and advise further work on blue carbon in Vanuatu. The three listed below in turn give access online to a wealth of relevant and useful information.

**The International Blue Carbon Initiative.** A collaboration between Conservation International (CI), the International Union for Conservation of Nature (IUCN) and the Intergovernmental Oceanographic Commission of the United Nations Educational, Social and Cultural Organization (IOC-UNESCO). The recently launched website ([www.thebluecarboninitiative.org](http://www.thebluecarboninitiative.org))

supports collaboration and coordination within the global blue carbon community. Through this online platform, the Initiative provides up-to-date information on its Scientific and Policy Working Groups, a general overview of blue carbon science and policy, as well as a compilation of existing field projects led by numerous partners around the world. Sign up for the latest blue carbon news here: [www.thebluecarboninitiative.org/category/resources/newsroom/](http://www.thebluecarboninitiative.org/category/resources/newsroom/). On the website you can also find "Profiles in Blue Carbon Field Work", a report which documents the work of a global community of scientists, policymakers and coastal communities on blue carbon as a nature-based tool to help mitigate global climate change. Blue carbon projects have great potential to work alongside technological advances that can mitigate the harmful effects of greenhouse gas emissions. In this study, 27 projects have been surveyed in order to provide a baseline understanding of the worldwide distribution and variety of attributes of current field activities. See the report at: <http://thebluecarboninitiative.org/wp-content/uploads/Profiles-in-Blue-Carbon-Field-Work.pdf>

**The Blue Carbon Portal.** Maintained by UNEP and GRID-Arendal the site provides a home for the international blue carbon community. The site is for all whom are actively working in or interested in blue carbon and the role of our coasts and oceans as carbon sinks – whether it be in the dissemination of publications, answering outstanding research questions, discussing policy and management issues, and including potential market applications. The portal brings together the latest knowledge and resources for blue carbon; it provides a central and accessible location to keep all parties up to date on new results, upcoming events, and find out who else is out there that might be tackling similar questions and challenges. See: <http://bluecarbonportal.org/>

**The Mangrove Alliance: a natural solution to a tangled issue.** An alliance set up in 2010 of BirdLife Partners and other organisations aims to conserve, restore and manage mangrove forests sustainably throughout the American tropics. The Neotropical Mangrove Conservation Alliance has already received a huge boost, with support from the MacArthur Foundation to coordinate activities put mangrove conservation actions in place at priority sites in the Caribbean islands. Of relevance to Vanuatu as it holds a particularly good online library of relevant mangrove publications. See: <http://www.birdlife.org/mangrove-alliance/resources/publications/>

# ANNEX 2.

## Experts met during the visit to Vanuatu

---

The following experts were consulted during the field visit to Vanuatu between 3rd and 12th February

### **In Port Vila:**

#### *The Blue Carbon Project Team:*

- Toney Tevi, Department of Foreign Affairs
- Sheena Luankon, Department of Foreign Affairs
- Donna Kalfatak, Department of Environment
- Rolenas Baereleo, Department of Environment
- Brian Philips, National Advisory Committee on Climate Change (NACCC)

#### *Ministry of Foreign Affairs:*

- Director General, Mr Johnny Koanapo
- Toney Tevi
- Sheena Luankon

#### *Department of Environment:*

- Donna Kalfatak
- Rolenas Baereleo
- Molu Bulu

#### *National Advisory Committee on Climate Change (NACCC):*

- Jotham Napat (Chairman of the Committee)
- Brian Philips

#### *Cultural Centre:*

- Francis Hickey

#### *Department of Lands:*

- Russel Nari, Deputy Director

### **In Malekula:**

- Palen Ata – Provincial Planner, MALAMPA Province
- Jerry Ngatu – Acting Secretary General, MALAMPA Province
- Kenos Fatdal – Area Secretary (Central Malekula), MALAMPA Province
- Kevin Morris – Fisheries Extension Officer, Fisheries Dept, Lakatoro, MALAMPA Province
- Nao Kainoma – JICA Fisheries Volunteer, Fisheries Dept, Lakatoro, MALAMPA Province
- Job Avo – Forestry Officer, Forestry Dept, Lakatoro, MALAMPA
- Kahlen Api – Chairman, Amal-Krab Bay Tabu Eria (AKTE) Manejmen Komiti, Lingarak Village
- Timothy Fredrick – Chief, TFC Village
- John Sandy, Chief, Uripiv Island
- Philip Ria – Deacon, Presbyterian Church, Uripiv Island
- Kaitan Olik – Chief, Tavaliaut Village
- Elder Sing – Church Elder, Tarem Village
- Karl Masing – AKTE Manejmen Komiti Member, Hatbol Village
- Willie Fred, Manager, Uri Marine Reserve, Uria Island
- Masing Wouljesele – Community Youth Member, Uri Island
- The Villagers of the Community of Uri Island

# ANNEX 3.

## Experts on blue carbon

---

Over the past few years experts have been identified on blue carbon around the world.

The Blue Carbon Portal provides lists of experts on blue carbon policy and science (<http://thebluecarboninitiative.org/category/protected/contact-list/>) that form a useful group of international contacts. Australia has a good number of key experts on blue carbon which is provided below, given Vanuatu's proximity in the Pacific Ocean and obvious opportunities for support and collaboration:

Dr Shay O'Farrell, Coordinator of the Blue Carbon group, Global Change Institute (GCI), University of Queensland.

Professor Cath Lovelock, joint lead for the GCI program, *Living with healthy Oceans*. As a core

member of the International Blue Carbon Scientific Working Group, Prof Lovelock is focusing GCI research on filling current research gaps.

Professor Ove Hoegh-Guldberg, Director, GCI, University of Queensland.

Professor Peter Mumby, ARC Laureate Professorial Fellow, GCI, University of Queensland.

Professor Stuart Phinn, Director, Centre for Spatial Environmental Research, University of Queensland.

Professor Peter Ralph, Executive Director of The Plant Functional Biology and Climate Change Cluster, University of Technology Sydney. Seagrass expert. Also core member of the International Blue Carbon Scientific Working Group.

# ANNEX 4.

## Blue carbon explained: a quick summary

The text below is reproduced edited extracts from *Capturing and conserving natural coastal carbon: building mitigation, advancing adaptation, 2010. World Bank, IUCN, ESA PWA.*, which draws its information in turn from: *Crooks, S., Herr, D., Laffoley, D., Tamelander, J. and Vandever, J. 2010. "Mitigating climate change through restoration and management of coastal wetlands and near-shore marine ecosystems: challenges and opportunities". Washington, DC.: World Bank, IUCN, ESA PWA.*

*Carbon stores in seagrass meadows and coastal wetlands—including coastal peats, tidal freshwater wetlands, salt marshes and mangroves are vast, unaccounted natural carbon sinks. The continued degradation of these coastal ecosystems through disturbance, drainage, reclamation and conversion to other land uses has resulted in substantial emissions of greenhouse gases (GHGs) and loss of natural carbon sequestration. Conserving and rebuilding these critical ecosystems not only mitigates GHG emissions, but delivers important co-benefits including ecosystem-based adaptation to climate change. A drive to protect and rebuild coastal wetlands and seagrass meadows calls for closer integration of these fragile land-ocean interfaces into national climate change actions and their inclusion into the activities of the international climate change dialogue.*

Coastal wetlands and seagrass meadows sequester large amounts of carbon within plants above and below sea-level as well as within soils. In comparison to terrestrial ecosystems, these ecosystems are continuously building carbon pools, providing for an ongoing and long-term removal of carbon dioxide from the atmosphere. Occupying only 2% of seabed area, vegetated wetlands represent 50% of carbon transfer from oceans to sediments. In many cases these soils have been continuously building for 5,000 years or more, and carbon stored in these sediments remain sequestered for millennia. Saline wetlands, like salt marshes, have the added advantage of emitting negligible quantities of methane. Although some coastal wetlands such as mangroves emit

other GHGs, over multi-century time scales all coastal wetlands are net sinks for GHGs.

Just as coastal wetlands capture and store carbon, drainage and other forms of degradation of these ecosystems release stored carbon from soils and plants. From an important carbon sink, the degraded wetlands become a significant source of GHG emissions. Clearance of mangroves immediately releases much of the carbon held within woody biomass. Drainage of all coastal wetlands immediately releases carbon from pools sequestered over recent centuries, and in following decades releases carbon that accumulated in soils over millennia. The rate of carbon emissions from coastal wetlands directly to the atmosphere is greatest in the immediate years after drainage and slows over time. Over the multi-decadal timeframe carbon emissions continue from the more organic-bearing, or peat-like, coastal wetland soils.

Conserving all coastal wetlands and seagrass meadows has an immediate benefit of preventing carbon dioxide release to the atmosphere. The carbon content of soils across the landscape varies and across different types of coastal wetlands but a 'typical' coastal wetland soil releases 0.25 million tons of CO<sub>2</sub> per square kilometer (km<sup>2</sup>) for every depth meter of soil lost. More detailed quantification is required but likely carbon emissions from brackish and freshwater tidal wetlands and oceanic mangroves (such as those found in open coastal/island settings) hold 50% or more carbon than this estimated average value, and some salt marshes and mangroves in deltaic settings may be 50% lower than this average value.

Some coastal systems have over the past 100–300 years released carbon from soils to a depth of 5–10 meters. The current rate of degradation and loss of coastal wetlands and submerged vegetated habitats is, in some instances, up to four times greater than that of tropical forests and leads to decreased carbon sequestration. With the loss of seagrass, carbon stored in underlying soils is

released back into circulation. Some portion of this carbon will be released into the atmosphere and some portion eventually reburied. Additional research is being undertaken to reduce current uncertainties. Carbon emissions from degraded (e.g. drained) and lost coastal wetlands are sufficiently significant to warrant inclusion in carbon accounting and GHG inventories. Next steps should also include development of financial incentive mechanisms for improved management and amendments to national and international policy frameworks to reduce loss of these ecosystems. With these in place, improved management of coastal wetlands and sea grass meadows could slow or reverse ongoing loss of carbon sequestration capacity.

Reducing carbon emissions through conservation and restoration of these ecosystems presents an opportunity for coastal nations to mitigate and adapt to climate change. Mitigation opportunities

through wetlands management are immediately available and can be cost effective as they generate a wide range of co-benefits from ecosystem services. The most effective way to maintain coastal wetland carbon pools is avoiding degradation and conversion through protection and sustainable management. Substantial gains can be achieved by restoring degraded coastal wetlands. Clearly, some coastal wetlands cannot easily be restored, but management activities such as rewetting of drained soils or replanting of mangroves can slow or halt carbon loss and reverse GHG emissions.

Sequestration rates during restoration are lower than rates at which carbon is lost when disturbed, reducing the mitigation potential in the short-term, but not in the long-term. Management of coastal wetlands and seagrass meadows is particularly important in developing countries, where co-benefits related to reduced vulnerability to climate change are particularly important.

# ANNEX 5.

## Carbon quantification methodologies

Due to the range of critical ecosystem services that blue carbon habitats provide they are potentially well suited to inclusion in climate change mitigation strategies. Alongside quantification of other ecosystem values, a prerequisite to understand the potential of mangroves is obtaining information on forest composition and structure and its ecosystem carbon pool. It is through this route as well as understanding associated issues such as permanence, leakage (see glossary at start of report for explanations) and governance that it will be possible to engage with carbon mitigation programmes, such as Reducing Emissions from Deforestation and Forest Degradation mechanism (REDD+).

The purpose of this annex is not to set out an ideal plan for carbon pool assessment but rather to guide the reader to suitable sources of information on methodologies from which to develop the strategy most appropriate to local situations. At the broadest level methodologies for mangroves build from broader forest sampling approaches (Kauffman and Donato 2012). Online resources on sampling methodologies and the establishment of sampling plots are available from a number of places as noted by Kauffman and Donato (2012), notably The Amazon Forest Inventory Network <http://www.geog.leeds.ac.uk/projects/rainfor/> and the Center for Tropical Forest Science <http://www.ctfs.si.edu/group/Resources/Methods>. Broader information of relevance that covers methodologies and carbon financing and markets can be found in GOFG-GOLD (2011), IPCC (2003, 2006) and Pearson et al. (2005, 2007).

In terms of specific methodologies for mangroves a good review can be found in Kauffman and Donato (2012). This sets out a generalised methodology to follow specific to mangroves, including information on field procedures, on laboratory and data analysis, and on reporting considerations. Many initiatives are starting to measure mangrove

carbon but a useful and recently published example of how this methodology has been applied can be found in Adame et al. (2013) who with colleagues recently quantified the ecosystem carbon stocks of coastal wetlands of the Sian Ka'an Biosphere Reserve (SKBR) in the Yucatan Peninsula, Mexico.

### References:

Adame MF, Kauffman JB, Medina I, Gamboa JN, Torres O, et al. (2013). Carbon Stocks of Tropical Coastal Wetlands within the Karstic Landscape of the Mexican Caribbean. *PLoS ONE* 8(2): e56569. doi:10.1371/journal.pone.0056569

GOFG-GOLD, 2011 A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals caused by deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation. GOFG-GOLD Report version COP17-1, GOFG-GOLD Project Office, Natural Resources Canada, Alberta, Canada.

Intergovernmental Panel on Climate Change (IPCC). 2003. Good practice guidance for land use, land use change, and forestry. Penman, J., Gytarsky, M. Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, K., Tanabe, K., Wagner, F. (eds.) IPCC, Geneva. <http://www.ipcc-nggip.iges.or.jp/public/gpplulucf/gpplulucf.html> (13 June 2011).

Intergovernmental Panel on Climate Change (IPCC). 2006. Guidelines, Volume 1 and Volume 4 (Agriculture, forestry, & other land use), Annex 2 (Summary of equations). IPCC, Geneva. <http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html> (13 June 2011).

Kauffman, J.B. and Donato, D.C. 2012 Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests. Working Paper 86. CIFOR, Bogor, Indonesia.

Pearson, T.R.H., Walker, S., Brown, S. 2005. Sourcebook for land use, land-use change and forestry projects. Report from BioCF and Winrock International. <http://www.winrock.org/ecosystems/tools.asp?BU=9086> World Bank, Washington DC.

Pearson, T.R.H., Brown, S.L., Birdsey, R.A. 2007. Measurement guidelines for the sequestration of forest carbon. General Technical Report- NRS-18, USDA Forest Service, Northern Research Station Newtown Square, USA.





**Commonwealth Secretariat**

Marlborough House, Pall Mall  
London SW1Y 5HX  
United Kingdom

[thecommonwealth.org](http://thecommonwealth.org)

