info brief

Incorporating blue carbon into Nationally Determined Contributions

Current status, opportunities and challenges of 13 Asia-Pacific countries

Pham Thu Thuy and Le Thi Thanh Thuy

Key messages

- This infobrief discusses the status, opportunities and challenges of incorporating blue carbon into the Nationally Determined Contributions (NDCs) of 13 Asia-Pacific countries (Bangladesh, Cambodia, Fiji, Indonesia, Malaysia, Myanmar, Papua New Guinea, Philippines, Samoa, Sri Lanka, Thailand, Vanuatu and Vietnam). While the role of mangroves is fully recognized in all countries' climate-change and environmental policies, only three (Indonesia, Malaysia and Philippines) explicitly referred to blue carbon terminology in their policies and established a national agency responsible for the development of a blue carbon strategy.
- The challenges associated with incorporating and implementing blue carbon into the NDCs of these 13 countries include a lack of data and standard methodology; weak technical capacity; a lack of coordination between government agencies and sectors; overlapping mandates and inconsistent policies; the increasing degradation of coastal wetland ecosystems; as well as funding constraints for developing and implementing policies and practices in programs focusing on the conservation of blue carbon ecosystems.
- Nevertheless, opportunities exist as stakeholders increase their understanding and awareness of blue carbon's role and importance at an international, national and sub-national level.
- The factors that can help stakeholders to seize these opportunities and contribute to the restoration of blue ecosystems include more policy and technical guidance for blue carbon management and reporting; further capacity enhancement; and improved coordination and information sharing among the relevant actors.

Introduction

The conservation and restoration of coastal ecosystems – including tidal salt marshes, seagrass meadows and mangrove forests (collectively called blue carbon ecosystems) – provide opportunities to develop nature-based solutions for climate-change mitigation and adaptation strategies. Blue carbon ecosystems can help to mitigate greenhouse gas (GHG) emissions due to high carbon storage and sequestration potential. These ecosystems also provide many goods and services to coastal communities. Despite the important role of blue carbon, the current GHG inventory process mostly follows the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, which do not differentiate between blue carbon ecosystems and terrestrial upland forests. Overlooking blue carbon ecosystems may result in the underestimation of GHG sinks and inaccurate reporting of GHG emissions at the national level. By excluding mangroves or the conversion of mangroves for other land uses, countries can also underestimate or overestimate their GHG emissions.

Global and national efforts to reduce emissions are demonstrated in Nationally Determined Contributions (NDCs). According to Herr and Landis (2016), out of 175 NDC submissions, 28 countries include blue carbon in their mitigation strategies and 59 countries include

it in their adaptation measures. Nations in the Asia-Pacific region, particularly East Asia, have a strong focus on blue carbon in their NDCs (Herr and Landis 2016) and several countries have expressed a commitment to developing blue carbon-based climate finance instruments (Arifanti et al. 2019; Espinesin and Evangelista 2019; William and Kalo 2019; Rungol and Peter 2019; Wulf and Kwan 2019; Tran and Nguyen 2019). Despite these positive signals, countries are still facing technical, financial and political challenges in their efforts to include blue carbon in their NDCs. There is also limited information or analysis on the current status of blue carbon integration in NDCs, as well as on the national approaches and opportunities for countries in addressing these challenges. Based on literature reviews, country reports and insightful discussions from an international workshop on "Incorporating Blue Carbon Into Nationally Determined Contributions" in Hanoi, Vietnam, on 9–10 July 2019, this paper discusses the national status on blue carbon as well as the opportunities and challenges associated with incorporating blue carbon into the NDCs of 13 Asia-Pacific countries (Bangladesh, Cambodia, Fiji, Indonesia, Malaysia, Myanmar, Papua New Guinea, Philippines, Samoa, Sri Lanka, Thailand, Vanuatu and Vietnam). The report also aims to provide decision makers with information on the importance of blue carbon ecosystems in the context of

climate change mitigation and adaptation; to discuss how mangrove and coastal blue carbon fits into national measurement, reporting and verification; and to share lessons learned from Asia-Pacific countries on possible ways and means to incorporate blue carbon ecosystems into the next round of NDC processes.

Current status of blue carbon in 13 Asia-Pacific countries

Table 1 shows that mangrove deforestation is widespread in the 13 Asia-Pacific countries, despite the high carbon-storage value that mangrove forests offer these nations. Data on total coastal and seagrass carbon storage are nonexistent or unavailable in most countries. These 13 countries also employ different approaches to incorporate blue carbon in their NDCs and climate change policies (see Table 2). Out of 13 countries, only three (Indonesia, Malaysia and Philippines) explicitly referred to blue carbon terminology in their policies and established a national agency (e.g. task force or steering committee) responsible for the development of a blue carbon strategy. However, four other countries (Cambodia, Papua New Guinea, Samoa and Vanuatu) are considering blue carbon for inclusion in their next NDC submission, and the role of mangrove is fully recognized in all countries' climate-change and environmental policies.

Opportunities for Blue Carbon

Stakeholders increase their understanding and awareness of blue carbon's role and importance at an international, national and sub-national level: The roles of blue carbon and mangrove have received more and more attention at an international and national level. An increase in funding and efforts to enhance the role and contribution of blue carbon (coastal wetland) ecosystems in NDCs, low-carbon development agencies, green growth strategies as well as climate change policies is evident in most countries. While some countries already have a legal framework and mandated government agencies working on blue carbon, many others are considering blue carbon for inclusion in their future NDC submissions. This development provides an enabling institutional environment to boost the role of mangroves in overall climate-change mitigation and adaptation solutions. Relevant institutional arrangements have also been put in place to facilitate the process. The Philippines' Blue Carbon Steering Committee and Technical Working Group; Myanmar's REDD+ technical committees; Malaysia's special task force on planting mangroves and other suitable species in coastal areas; and Vanuatu's National Advisory Board on Climate Change and Disaster Risk Reduction are examples of existing institutions that can be utilized to put blue carbon on the agenda for the revision of NDCs.

Table 1. Current status of blue carbon in 13 Asia-Pacific countries

	Mangrove area (ha)	Carbon storage from mangroves	Annual deforestation	Seagrass area (ha)	Carbon storage from seagrass	Total coastal carbon storage
Indonesia	3.1 million (3% of total forested land)	1,083 Mg C ha^{-1} (Arifanti 2019)	52,000 ha (Arifanti 2019)	3 million	119.5 Mg C ha^{-1}	3.3x1015 Mg C (Arifanti 2019)
Malaysia	629,038 (3% of total forested land) (Malaysia's Open Data Portal, 2017)	Penang: Mangrove, aboveground 158.9 Mg C ha^{-1} Kuala Selangor: Mangrove, aboveground 122.77–305.03 Mg C ha^{-1} and belowground 226.1–252.6 Mg C ha^{-1}, 30 cm sediment Langkawi: Mangrove, belowground storage 263.4 Mg C ha^{-1}, 1 m sediment Matang mangrove: successfully managed model, aboveground carbon stock (114 Mg C ha^{-1}) and deposition rate of C in sediment (1.5 Mg C ha^{-1} yr-1) Johor: Mangrove, aboveground 111 – 131 Mg C ha^{-1} (Mohti and Salimun 2019)	96,000 ha	1,630	Johor: Seagrass meadow, belowground 43-101 Mg C ha^{-1}, 1 m (Mohti and Salimun 2019)	Not available
Philippines	310,593 (4.54% forest land in 2010) (Cabico 2018)	Botoc: 691.81 t CO2 ha^{-1} (Abino, Castillo and Lee 2014) Verde Island Passage: 115.45 ton/ha for *Rhizophora*-dominated stands and 141.71 Mg/ha for *Avicennia*-dominated stands	47,000 (Cabico 2018)	27,282	Lian, Batangas: 1.94 Mg ton/ha (Philippines Ecosystem Research and Development Bureau 2018)	Not available

Table 1. Continued

	Mangrove area (ha)	Carbon storage from mangroves	Annual deforestation	Seagrass area (ha)	Carbon storage from seagrass	Total coastal carbon storage
		Tayabas Bay: 92.36 ton/ha for *Rhizophora*-dominated stands and 139.07 ton/ha for *Avicennia*-dominated stands (Gevana, Im and Pulhin 2010)				
Cambodia	57,132 (Cambodia Ministry of Environment 2018) (0.65% total forest land)	Not available	89,441 (Mongabay)	32,489 (Fortes et al. 2018)	Not available	Not available
Thailand	236,500	4.9 ton-C ha^{-1}/yr (Tateda, Imamura and Ishi 2005)	4,763 (Mongabay)	25,500	110 – 140 Mg/ha (Stankovic, Tantipisanuh and Prathep 2018)	Not available
Myanmar	299,000 ha, 4% of land area	73 Mg C/ ha in natural regenerated forest, 43 Mg C ha^{-1} in *Sonneratia apetala*, 21 Mg C ha^{-1} in *Avicennia marina* (Am) and 18 Mg C ha^{-1} in *Avicennia officinalis* (Thant, Kanzaki, Ohta and Than 2012)	38,086 (Mongabay)	430	Not available	5.04 ± 2.66 ton C/ha aboveground (Thin and San 2019)
Vanuatu	2,519 (FAO, 2000) (0.21% land area)	155-747 Mg C/ha (Malama SM 2013) Crab Bay: 243 – 513 Mg C/ha Eratap: 245 – 518 Mg C/ha (Pascal and Bulu 2014)	467.8 (Herold, Sambale, Lindner and Urban 2007)	Not available	Not available	Not available
Papua New Guinea	553,421 (1.2% of the area, 2% of forest cover)	534 Mg C/ha (Hamilton and Friess 2018)	56,784 (Mongabay)	4,564,132	Not available	Not available
Samoa	700 (FAO, 1995)	Le Asaga Bay: 188 – 520 Mg C/ha (Hamilton and Friess 2018)	Not available	Not available	Not available	Not available
Vietnam	270,000	2.0 ton/ha/yr (Tateda, Imamura and Ishi 2005)	46,014 (Mongabay)	17,675	Not available	Not available
Bangladesh	441,455 (Chowdhury et al. 2015)	4.73 ton/ha/yr	Not available	660,048	10.26 ton/ha/yr	Not available
Fiji	42,464 (Mangroves in Fiji)	327-950 t ha^{-1} (Pascal and Bulu 2014)	Not available	Not Available	Not available	Not available
Sri Lanka	15,669 ha (0.2%)	94 – 406 Mg/ha	12,644 (Mongabay)	23,819	No data available for tidal marshes and seagrass beds	Not available

Accumulated experience and lessons learned can be consolidated to provide local practices and solutions for the harmonization of conservation and development: Local practices and solutions are being piloted widely (e.g. in Indonesia) for the coastal rehabilitation of blue carbon ecosystems in combination with ecosystem-based economic activities in order to harmonize conservation and development.

International and regional initiatives/partnerships are in place to address technical issues: International initiatives – such as REDD+ and its measurement, reporting and verification system – have laid good foundations for several countries, including Papua New Guinea and Samoa, to further consider including blue carbon in their GHG inventories once all parties agree on the methodology. Moreover, it might be too costly for a single country to carry out the

Table 2. National approaches to incorporating blue carbon in NDCs and climate-change policies

Countries	Approaches
Indonesia	• Indonesia Blue Carbon Strategy Framework is being developed for the National Medium-Term Development Plan (RPJMN) 2020-2024 and will be implemented by different agencies in charge of development and planning, marine policies, fisheries and natural resources conservation • Presidential decrees and regulations aim to conserve and sustainably use the oceans, seas and marine resources. These will be implemented by government agencies, CSOs and the private sector at a national and sub-national level. In particular, the aim is to recover 1.82 million ha of mangrove ecosystems by 2045. This should be achieved by rehabilitating 60,000 ha/year. • Integrate into the national GHG inventory
Malaysia	• Special national task force on the planting of mangroves and other suitable species in coastal areas • National initiatives to protect and restore coastal blue carbon ecosystems • National policies to mitigate and adapt to CC impacts through sustainable forest management, including mangroves
Philippines	• National Climate Change Action Plan (NCCAP) 2011-2028; Philippine Development Plan (PDP) 2017-2022; Executive Order No. 533: Integrated Coastal Management (ICM) all refer to blue carbon • The Blue Carbon Steering Committee (BCSC) and the Blue Carbon Technical Working Group (BCTWG) of the Philippines. The Commission Resolution on Blue Carbon stated: "The Philippines intends to harness the adaptation and mitigation potential of Blue Carbon, which could be included in the subsequent submission of the Nationally Determined Contribution." • The steering committee is comprised of government agencies that set the policy direction, while the technical working group consists of government agencies, CSOs, academic institutions and the private sector to undertake and promote research on blue carbon. The BCTWG also provides technical assistance and advice to the BCSC and Cabinet Cluster on Climate Change Adaptation and Mitigation (CCAM) for the development and implementation of the National Blue Carbon Initiative. • Programs and projects, such as the National Greening Program's Mangrove and Beach Forest Development Project (MBFDP)
Cambodia	• Blue carbon is not yet well incorporated into the INDC, but the country is committed to implementing SDG 14 to scale up marine conservation and biodiversity efforts • Ongoing development of the country's Environment and Natural Resources Code, projects and programs on CC adaptation, pollution reduction and waste management, livelihood management, ICM, habitat protection and restoration, and fisheries management
Thailand	• Does not refer to blue carbon yet
Myanmar	• Not yet specified in any policies, but a legal framework is in place to support blue carbon in the future through the Myanmar Climate Change Policy; Strategy and Master Plan; and the country's green growth strategy
Vanuatu	• Assessment of Vanuatu's blue carbon potential was conducted by the Commonwealth Secretariat 2012/13 • Mangroves and seagrass meadows were identified as two blue carbon ecosystems in Vanuatu. Ongoing work in two ecosystems but not specific to blue carbon – conservation, restoration, REDD+ and NFI • Blue carbon included in NDC but would need to be given greater emphasis in future NDCs
Papua New Guinea	• Blue carbon and wetlands are not included in the NDC but are being considered for inclusion in future NDCs • Blue carbon work is currently being carried out mostly on mangroves, little on seagrass
Samoa	• Review NDC and consider blue carbon as carbon sinks • National program on Mangrove Ecosystems for Climate Change Adaptation and Livelihoods (MESCAL) • At least 20 community mangrove projects under SGP have been implemented, are in progress or are in the pipeline
Vietnam	• The country does not use the term 'blue carbon' in its NDC but the role of mangroves is recognized in both adaptation and mitigation actions
Bangladesh	• The country does not use the term 'blue carbon' in its NDC but the role of mangroves is recognized in both adaptation and mitigation actions under the Bangladesh Climate Change Strategy and Action plan (BCCSAP) • About 1,500,000 ha of mangrove plantations have been raised so far and these new plantations are playing an important role in carbon sequestration. • To protect the coastal belt, the country has declared the Swatch of No Ground canyon as a marine protected area. • The government has declared 18 protected areas, two of which are in coastal areas.

Table 2. Continued

Countries	Approaches
Fiji	• Has not included mangroves in its current FRL due to a lack of information but it will include mangroves later in the national FRL as they meet the national definition of forests • Has not included forests and blue carbon in NDCs • A mangrove management committee has been established to develop a national plan • Has policies and regulations in place but not specific to blue carbon
Sri Lanka	• The Ministry of Mahaweli Development and Environment has established a task force on mangrove conservation consisting of members from stakeholder institutions. There is also a national expert committee on mangrove conservation and sustainable use, consisting of experts in this field.

Sources: Arifanti et al. 2019; Espinesin and Evangelista 2019; William and Kalo 2019; Rungol and Peter 2019; Wulf and Kwan 2019; Tran and Nguyen 2019; Mohti and Salimun 2019; Kim and Uy 2019; Tangphoomrapeewong and Boonsamret 2019; Thin and San 2019; Chakraborty and Rahman 2019; Premakantha and Perera 2019; Lotawa and Lagataki 2019

mapping of blue carbon. Regional initiatives – such as the Pacific Blue Carbon Initiative (funded by Australia) – help Pacific nations to map blue carbon and to collect data, while enhancing their technical capacity in policy development and research on blue carbon ecosystems. This provides great opportunities for countries to exchange knowledge and skills on these topics.

Potential funding can be generated by the blue carbon economy through sustainable fishing, shipping and eco-tourism in productive zones, as well as public-private partnerships. These are sustainable and innovative financial solutions that can help countries to overcome challenges.

Challenges

All countries are facing numerous challenges in their efforts to integrate blue carbon into their NDCs and climate change policies (see Figure 1).

Technical challenges: lack of data and standard methodology as well as weak technical capacity to monitor mangrove ecosystems

The most-mentioned challenge is the lack of country-specific data and standard methodology to quantify the level of carbon emissions and sequestrations for disturbed, degraded, restored and intact blue carbon ecosystems.

At an international level, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and the IPCC's Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003) do not provide adequate instruction to calculate emissions and activity data in order to carry out the GHG inventory. There is also no standard methodology used to estimate blue carbon areas at an international and national level. As a result, it is difficult to make a comparison between studies. The national technical capacity – especially with regard to the implementation of the 2013 Wetlands Supplement – is often weak (e.g. in Papua New Guinea).

At the national level – despite many individual projects and scientific studies having analyzed the carbon sequestration
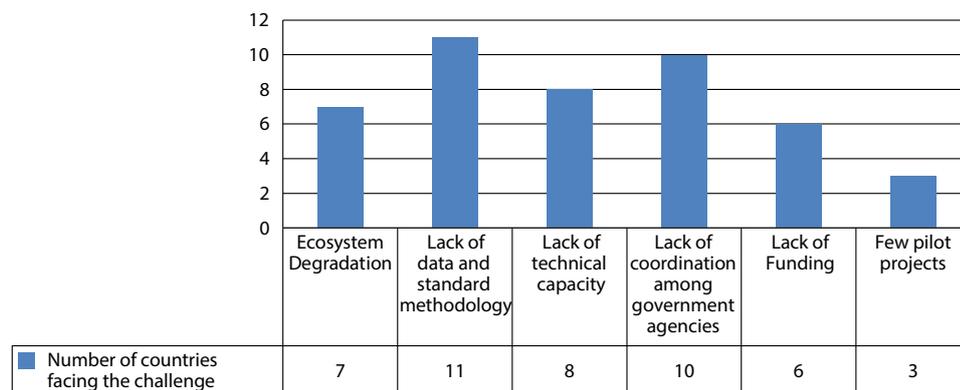
of marine and coastal ecosystems at several sites – there is no monitoring and evaluation system or relevant database using consistent, rigorous and scientific methods. Three questions raised by Chowdhury et al. (2017) – "*Where are blue carbon ecosystems currently located? How much area do these habitats cover? What amount of carbon could be stored (sequestered) in these habitats?*" – are mostly unanswered at a national level in all countries. There are also few or no locally developed allometric equations to calculate carbon sequestration and storage for mangroves in a national context.

In addition, there is much less research on mangrove carbon sequestration than on terrestrial forest ecosystems. Available research and data on seagrass, tidal sea marshes and other marine ecosystems are rare or even nonexistent in most countries. Baseline data and basic information are also lacking in many countries and the data are often inconsistent. Most countries have national reforestation and rehabilitation programs for both inland and mangrove forests. However, monitoring these programs over time to generate regular data on their distribution and status has not been implemented (e.g. Philippines, Vietnam). There is also little or no data on the quantification of emissions and carbon sequestration based on disturbed, degraded, restored and natural blue carbon ecosystems (e.g. Philippines). Countries are also impeded by the lack of scientific knowledge on restoration methods and species selection, particularly on tidal marsh restoration.

Although there are existing tools and software to calculate carbon stocks, countries have not adopted them due to the lack of information and technical skills to use them in a national context. Several nations – Malaysia, Papua New Guinea and Vietnam – have inadequate definitions of mangrove and fail to distinguish between mangroves and salt marshes sufficiently in a legal framework, causing difficulties in collecting and reporting these data.

Lack of coordination among government agencies and sectors, overlapping mandates and inconsistent policies

In most countries, multiple government agencies have the management rights and responsibilities over mangroves. However, these powers are not clearly defined, leading to overlapping

Figure 1. Challenges facing countries in incorporating blue carbon

	Ecosystem Degradation	Lack of data and standard methodology	Lack of technical capacity	Lack of coordination among government agencies	Lack of Funding	Few pilot projects
Number of countries facing the challenge	7	11	8	10	6	3

mandates (e.g. Cambodia, Papua New Guinea, Sri Lanka and Vietnam) and conflicts over financial resources (e.g. Indonesia and Philippines). Weak coordination among government agencies is also widespread in most countries and contributes to conflicting policies that also impede effective mangrove protection and development. For example, while the national forest protection and development plan in Vietnam aims to protect existing mangrove areas, provincial authorities at a sub-national level have an aquaculture development plan that involves clearing a large area of mangroves (Pham et al. 2018). Moreover, there are a large number of policies and projects related to mangrove protection and development in most countries, but the enforcement of these policies is often weak.

Increasing degradation of coastal wetland ecosystems (mangroves and seagrass) – the rate of degradation is higher than the rate of rehabilitation (e.g. Indonesia)

As national economic development has progressed, mangroves and blue carbon ecosystems have increasingly been subject to deforestation and degradation over time, while mangrove reforestation and rehabilitation schemes have been unable to keep pace with the deforestation rate. For example, the national target to increase intensive shrimp production for export; pollution from tourism; the effects of oil spills; and the construction of ports have all led to the massive destruction of mangrove forests and coastal ecosystems.

Financial challenges for the implementation of policies and practices in programs focusing on the conservation of blue carbon ecosystems are mentioned in the country reports of Cambodia, Papua New Guinea, Sri Lanka and Vanuatu. These countries see funding as one of the key challenges for data collection and proper mangrove management. Current funding programs, benefit-sharing mechanisms and the offering of incentives are not enough to change behavior and encourage stakeholders to move away from their business-as-usual model involving mangrove deforestation and degradation. Finding sustainable sources of finance to support marine protected areas and coastal ecosystems is a priority in most countries.

Recommendations

To address challenges and to seize opportunities, country representatives have called for action at different levels. At an international level, policy and technical guidance is needed for blue carbon management and reporting. At the national level, cross-sectoral coordination and sustainable financing for the management of mangroves and coastal ecosystems are required to address their sharp decline in these countries and to enhance the environmental benefits provided by mangroves. Capacity building is needed for national stakeholders to implement the Wetlands Supplement, and research funding should be allocated to address the current lack of necessary data and information on seagrass; to include mangrove soils in GHG inventory reporting; to gain more accurate data on ecosystem C stocks as well as emissions from mangroves and seagrass; and to develop the national profiles of existing blue carbon ecosystems. North-south and south-south collaboration and information sharing can also help developing countries to obtain the knowledge and skills required to implement strategic policies and research supporting the sustainable development of blue carbon and coastal ecosystems. Cooperation between state and non-state actors should also be strengthened to provide an adequate platform for a participatory decision-making process. Addressing the drivers of deforestation and degradation – which are often rooted in national efforts to boost the economy– also requires a strong government commitment and effective law enforcement. Public-private partnerships as well as sustainable actions from the blue carbon economy can also help to harmonize environmental and economic interests.

Acknowledgements

References/sources

Abino AC, Castillo JAA and Lee YJ. 2014. Assessment of species diversity, biomass and carbon sequestration potential of a natural mangrove stand in Samar, the Philippines. *Journal of Forest Science and Technology* 10(1):2–8.doi: 10.1080/21580103.2013.814593

Arifanti V, Zamzani F, Sidik F and Siry HY. 2019. Indonesia country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Cabico GK. 2018. *Recovering the Philippines' forest cover.* Accessed on 17 September 2019. https://www.philstar.com/headlines/2018/03/04/1793446/recovering-philippines-forest-cover

Cambodia Ministry of Environment. 2018. *Cambodia Forest Cover 2016.* Phnom Penh, Cambodia: Cambodia Ministry of Environment. https://redd.unfccc.int/uploads/54_3_cambodia_forest_cover_resource__2016_english.pdf

Chowdhury SR, Hossain MS, Sharifuzzaman SM and Sarker S. 2015. *Blue Carbon in the Coastal Ecosystems of Bangladesh.* Project Document, Support to Bangladesh on Climate Change Negotiation and Knowledge Management on Various Streams of UNFCCC Process Project. IUCN Bangladesh Country Office

Chakraborty DK and Rahman R. 2019. Bangladesh country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Espinesin C and Evangelista A. 2019. Philippines country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

[FAO] Food and Agriculture Organization of the United Nations. 2000. *FAO country summary report: Samoa.* Rome: FAO. Accessed on 17 September 2019. http://www.fao.org/3/AD672E/ad672e16.htm

[FAO] Food and Agriculture Organization of the United Nations. 2000. *FAO Forest Resource Assessment, Vanuatu Country Report.* Accessed on 17 September 2019. http://www.fao.org/3/AD672E/ad672e18.htm

Fortes MD, Ooi LSJ, Yi MT, Prathep A and Bujang JS. 2018. Seagrass in Southeast Asia: a review of status and knowledge gaps, and a road map for conservation. *Botanica Marina 61(3)*: 269–288 . doi: 10.1515/bot-2018-0008

Gevana DT, Im SJ, Pulhin FB and Pampolina NM. 2010. *Carbon stock assessment of the mangrove ecosystem in Verde Island Passage and Tayabas Bay, Luzon, Philippines,* presented at XXIII IUFRO World Congress 2010 in Seoul, Republic of Korea, 23–28 August 2010. Available at: https://www.researchgate.net/publication/326675982_Carbon_Stock_Assessment_of_the_Mangrove_Ecosystem_in_Verde_Island_Passage_and_Tayabas_Bay_Luzon_Philippines

Hamilton SE and Friess DA. 2018. Global carbon stocks and potential emissions due to mangrove deforestation from 2000 to 2012. *Nature Climate Change* 8(3):240–244. doi: 10.1038/s41558-018-0090-

Herold M, Sambale J, Lindner M and Urban M. 2007. *Vanuatu Forest Change Assessment 1990-2000 using satellite data.* Phase I Project Report No. 1, Vanuatu Carbon Credits Project: Vanuatu Forests – Reducing Emissions. Victoria University of Wellington. http://www.carbonpartnership.co.nz/uploads/8/2/1/0/8210062/vccp_forest_area_change_assessment_1990-2000_report.compressed.pdf

Herr D and Landis E. 2016. *Coastal blue carbon ecosystems. Opportunities for Nationally Determined Contributions.* Policy Brief. Gland, Switzerland: IUCN and Washington, DC, USA: TNC.

Lotawa MD and Lagataki TS. 2019. Fiji country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Mohti A and Salimun HABM. 2019. Malaysia country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Mongabay. Deforestation statistics for Myanmar. Accessed on 17 September 2019. https://rainforests.mongabay.com/deforestation/archive/Myanmar.htm

Mongabay. Deforestation statistics for Papua New Guinea. Accessed on 17 September 2019. https://rainforests.mongabay.com/deforestation/archive/Papua_New_Guinea.htm

Mongabay. Deforestation statistics for Sri Lanka. Accessed on 17 September 2019. https://rainforests.mongabay.com/deforestation/archive/Sri_Lanka.htm

Mongabay. Deforestation statistics for Thailand. Accessed on 17 September 2019. https://rainforests.mongabay.com/deforestation/archive/Thailand.htm

Mongabay. Deforestation statistics for Vietnam. Accessed on 17 September 2019. https://rainforests.mongabay.com/deforestation/archive/Viet_Nam.htm

Mongabay. Deforestation statistics for Cambodia. Accessed on 17 September 2019. https://rainforests.mongabay.com/deforestation/archive/Cambodia.htm

Nong K and Kamal U. 2019. Cambodia country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Malama SM. 2013. *Le Asaga Bay Mangroves Biodiversity.* Project report, Mangrove Ecosystem for Climate Change Adaptation and Livelihoods (MESCAL) Samoa project. IUCN. https://www.iucn.org/sites/dev/files/mangroves_biodiveristy_assessment_report_samoa.pdf

Malaysia's Open Data Portal. 2017. *Malaysia forested area data.* Accessed on 17 September 2019. http://www.data.gov.my/

data/dataset/malaysia-total-forested-area-2017/resource/ae840cfe-35cd-4cf7-9de2-2f0571185437

Mangroves for Fiji. *Mangroves in Fiji*. Accessed on 17 September 2019. http://mangrovesforfiji.com/mangroves/mangroves-in-fiji/

Pascal N and Bulu M. 2014. *Economic valuation of mangrove ecosystem services in Vanuatu: Case studies of Crab Bay (Malekula Is.) and Eratap (Efate Is.)*. Final project report, Mangrove Ecosystem for Climate Change Adaptation and Livelihoods (MESCAL) project. IUCN. https://www.iucn.org/sites/dev/files/economic_valuation_of_mangrove_ecosystems_vanuatu_full.pdf

Philippines Ecosystem Research and Development Bureau. 2018. *Ph to tap huge ocean carbon stock potential, to sequester significant pollutant CO2*. Accessed on 17 September 2019. http://erdb.denr.gov.ph/2018/09/27/ph-to-tap-huge-ocean-carbon-stock-potential-to-sequester-significant-pollutant-co2/

Premakantha KT and Perera GTD. 2019. Sri Lanka country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Rungol A and Peter I. 2019. Papua New Guinea country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019 Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Stankovic M, Tantipisanuh N and Prathep A. 2018. Carbon storage in seagrass ecosystem along the Andaman coast of Thailand. *Botanica Marina* 61(5): 429–440. doi: 10.1515/bot-2017-0101.

Thant YM, Kanzaki M, Ohta S and Than MM. 2012. Carbon sequestration by mangrove plantations and a natural regeneration stand in the Ayeyarwady Delta, Myanmar. *J-STAGE* 21(1):1–10.

Tateda Y, Imamura M and Ishi T. 2005. *Estimation of CO2 Sequestration Rate by Mangrove Ecosystem*. Environmental Science Research Laboratory. Available at: https://criepi.denken.or.jp/en/publications/annual/2005/05juten16.pdf

Tangphoomrapeewong A and Boonsamret P. 2019. Thailand country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Thin TW and San W. 2019. Myanmar country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Tran TBN and Nguyen TC. 2019. Vietnam country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

William L and Kalo N. 2019. Vanuatu country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/

Wulf A and Kwan S. 2019. Samoa country presentations on NDCs and coastal blue carbon ecosystems and activities, presented at Regional Workshop on Incorporating Blue Carbon Into Nationally Determined Contributions, 8–10 July 2019, Hanoi, Vietnam. Available at: https://www.cifor.org/blue-carbon-ndc-workshop/