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Abu Dhabi Global Environmental Data Initiative

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Abu Dhabi Blue Carbon Demonstration Project

Contract Ref: PCD-NK/AGEDI/23/12

Carbon Baseline Assessment Methodology Report

GRID ARENDAL

هيئة البيئة - ابوظبي
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1 Introduction

1.1 Project Context

"Blue Carbon" refers to the functional attributes of coastal and marine ecosystems to sequester and store carbon. Blue Carbon ecosystems of the United Arab Emirates (UAE) include mangrove forests, salt marshes and seagrass beds. Another potential Blue Carbon ecosystem identified as a result of this project is cyanobacterial "blue-green algal" mats (hereafter called algal flats). When these ecosystems are destroyed, buried carbon can be released into the atmosphere, contributing to global warming. In addition to their climate related benefits, Blue Carbon ecosystems provide highly valuable *Ecosystem Services* to coastal communities. They protect shorelines, provide nursery grounds for fish and habitats for a wide range of terrestrial and aquatic species, and support coastal tourism. They also have significant cultural and social values.

The Abu Dhabi Blue Carbon Demonstration Project aims to improve our understanding of carbon sequestration and the other services that coastal and marine Blue Carbon ecosystems provide in the Emirate and in addition, contribute to the improved understanding of this relatively new concept on a regional and international level. The project will enhance local capacity to measure and monitor carbon in coastal ecosystems and to manage associated data. The project also identifies options for the incorporation of these values into policy and management and lead to sustainable ecosystem use and the preservation of their services for future generations.

1.2. International Context

The Blue Carbon concept has strengthened interest in the management and conservation of coastal marine ecosystems, supporting climate change mitigation efforts. However, there are still gaps in the understanding of Blue Carbon, and incentives and policies are needed to ensure more sustainable environmental management practices.

The experience and knowledge gained from the project will help guide other Blue Carbon projects and international efforts, such as the International Blue Carbon Initiative,[1] and the Global Environment Facility's (GEF) Blue Forests Project, of which Environment Agency – Abu Dhabi (EAD) are a partner. This project provides a carbon stock inventory for intertidal and subtidal natural Blue Carbon ecosystems, as well as planted mangroves, in an arid region, reducing gaps in the global database. Recognition of algal flats as a Blue Carbon ecosystem emphasizes the importance of understanding coastal carbon cycling in arid regions of the world. The project also has helped develop Blue Carbon science and data management through the production of tools and the testing of methodologies that can be utilized and up-scaled to the international arena to enhance international Blue Carbon cooperation and training.

[1] http://thebluecarboninitiative.org/

1.3. Project Setting

In just over 40 years, Abu Dhabi has evolved from a small fishing community to the largest of the seven Emirates of the UAE. With the vision and direction from His Highness the late Sheikh Zayed Bin Sultan Al Nahyan, the environment has become an intrinsic part of the heritage and traditions of the people of the UAE. This national affinity to the sea has led to the initiation of the Abu Dhabi Blue Carbon Demonstration project in order to explore the values which coastal ecosystems provide the UAE, and to help preserve our environmental and cultural heritage. The project, commissioned by the Abu Dhabi Global Environmental Data Initiative (AGEDI) on behalf of EAD will run until the end of 2013.

1.4. Project Structure

The project is comprised of five components:

1) A **carbon baseline assessment** that has quantified the stocks of carbon for coastal ecosystems, and rate of carbon sequestration associated with mangrove afforestation (This report provides supplemental information on field and laboratory analysis);
2) A **geographic assessment** that has mapped Abu Dhabi's Blue Carbon ecosystems and provides a carbon analysis tool to support informed decision making;
3) An **ecosystem services assessment** that investigated the goods and services beyond carbon sequestration that Blue Carbon ecosystems provide Abu Dhabi;
4) A **policy component** that identifies the most suitable options for incorporating Blue Carbon and Ecosystem Services in Abu Dhabi's policy and governance frameworks; and
5) A **Blue Carbon and ecosystem services finance feasibility assessment** that recommends the most feasible policy and market options for implementing Blue Carbon projects in Abu Dhabi.

1.5. Science Team

The Principal investigators of this study are members of the International Blue Carbon Scientific Working Group[2]. The goals of this voluntary network are to:

1) Assess the feasibility of coastal Blue Carbon as a conservation and management tool and its potential for climate change mitigation;

2) Provide implementable recommendations for coastal marine conservation and management that maximizes sequestration of carbon and avoids emissions in coastal systems;

[2] Hosted by Conservation International, the International Union for Conservation of Nature (IUCN), and the Intergovernmental Oceanographic Commission (IOC), this working group of scientists assists in the building of capacity for the understanding of carbon cycling by coastal marine ecosystems. The Science Working Group runs in parallel with the International Blue Carbon Policy Working Group under the Blue Carbon Initiative.

3) Establish a network of demonstration projects to quantify carbon stocks and fluxes, test protocols for monitoring, reporting and verification;

4) Promote and support scientific research on carbon cycling by coastal Blue Carbon ecosystems.

Dr. Stephen Crooks is an independent consultant, as well as Climate Change Program Manager at Environmental Science Associates, a US based environmental consultancy. He is a practitioner in wetlands restoration and specializes in planning for climate change adaptation and mitigation. He is a founder of the Blue Carbon Initiative, and member of both the International Blue Carbon Scientific and Policy Working Group, a member of the Intergovernmental Panel on Climate Change (IPCC) Expert Working Group developing supplementary guidance for national greenhouse gas accounting to include wetlands, a Steering Committee Member of the IUCN Species Survival Commission (SSC) Mangrove Specialist Group, and an AFOLU expert for Wetland Restoration and Conservation category under the Verified Carbon Standards (VCS) Registry. He is working with Restore America's Estuaries to establish a global VCS wetlands restoration carbon offset methodology, and the United Nations Environment Programme (UNEP) to develop best practice guidelines for coastal wetlands carbon projects.

Dr. Patrick Megonigal is a Senior Scientist at the Smithsonian Environmental Research Centre, USA, and principal investigator of the Smithsonian Global Change Research Wetland. His major research interests concern wetland ecosystems, with an emphasis on the impacts of global change on carbon cycling. Dr. Megonigal was President of the Society of Wetland Scientists in 2007. His work includes membership on the US National Blue Ribbon Panel on Wetland Carbon Offsets, International Blue Carbon Scientific Working Group, the Restore America's Estuaries Working Group on Blue Carbon Offsets, and advising the State of Louisiana on Blue Carbon Offsets.

Dr. Boone Kauffman is a professor of Ecosystem Studies in the Department of Fisheries and Wildlife at Oregon State University and a Senior Associate with the Centre for International Forestry Research. He is a member of the IPCC, the International Blue Carbon Science and Policy Working groups, and is a science advisor to the Coalition for Rainforest Nations. Dr. Kauffman's research focus is on the relationships between land use, climate change, and carbon dynamics of tropical wetland ecosystems.

Dr. James Fourqurean is a Professor of Biological Sciences and the Director of the Marine Research and Education Initiative for the Florida Keys at Florida International University (FIU) in Miami, Florida, USA. He is a marine and estuarine ecologist with a special interest in benthic plant communities, food webs, and nutrient biogeochemistry. He is an expert in carbon storage and fluxes in coastal ecosystems, and the importance of these ecosystems to climate regulation and mitigation. In this role, he serves on both the Science and Policy Working Groups of the International Blue Carbon Initiative.

The team is supported by Dr. Lisa Schile, Post-Doctoral Research Fellow at the Smithsonian Institution's Environmental Research Centre. Topographic survey support was provided by Mr. James Kulpa of Environmental Data Solutions.

1.6. Report Organisation

This report provides additional information to support future blue carbon field campaign and laboratory analysis. Details of the Blue Carbon Assessment Report can be found at www.AGEDI.ae

1.7. Acknowledgements

This methodology report has been prepared in response to the strategic leadership of H.E. Razan Khalifa Al Mubarak, Secretary General of Environment Agency – Abu Dhabi (EAD) and Dr. Fred Launay, Senior Advisor to the Secretary General.

The EAD's Terrestrial and Marine Biodiversity Sector Marine Division, in particular Edwin Grandcourt, Himansu Das, Ibrahim Bulga, Ahmed Alanzi, Maitha Al Hameli, Hada Al Mahairbi and Mohammed Al Ali, and AGEDI's Ms. Jane Glavan, Ms. Huda Petra Shamayleh, and Ms. Larissa Owen provided expertise, local knowledge, participation in the field, and commitment to Abu Dhabi's Blue Carbon Ecosystems. We are grateful for logistical management from GRID-Arendal's Robert Barnes, Christian Neumann and Emma Corbett, who together ensured that these assessments were possible. Particular thanks is also extended to project stakeholders and field volunteers from organisations including: Zayed University; Abu Dhabi National Oil Company; The Higher Colleges for Technology; Takatoff; Al Mahara Diving Company, as well as the Abu Dhabi community and International partners Ms. Restu Nur A Fiati, and Ms. Terry Lousie Kepel from Blue Carbon Indonesia and Lalao Aigrette and Trevor Jones from Blue Ventures Madagascar.

2 Ecosystems of Interest

2.1.1 Mangroves

Mangroves (Figure 1a) are found in scattered coastal locations, particularly around the margins of lagoons and mud banks behind the barrier islands such as Abu Dhabi Island and on the outer islands. *Avicennia marina* is the only native mangrove species (Embabi, 1993), although *Rhizophoraceae* was identified in charcoal fragments dating back to between 2,500 and 4,000 years ago (Environmental Agency, 2006).

Recognizing the importance of mangroves, His Highness the later Sheikh Zayed bin Sultan Al Nahyan initiated a programme of mangrove planting to maintain and expand these forests (Figure 1g-j). Mangrove planting has been on-going since the mid 1960's in the Eastern Mangrove region, and more recently in Abu Al Abyad. This includes revegetation along abandoned channels and degraded sites formally occupied by mangroves. In addition, expansive engineering works involving excavation of coastal sabkha and algal flats for the purpose of mangrove planting are on-going on the mainland areas landward of Abu Al Abyad. Both naturally occurring and planted mangrove plantations, if present, should be assessed.

2.1.2 Salt marshes

Salt marshes are relatively limited in extent, occurring in patches along the fringe of sabkha, locally on sand veneers, adjacent to channels with sabkha, and amongst higher intertidal areas of mangrove strands. The salt marshes are dominated by the succulent, halophytic shrub *Arthrocnemum macrostachyum* (Figure 1f) and subdominent species *Halocnemum strobilaceum, Halopeplis perfoliata, Suaeda vermiculata, Salicornia europaea, Limonium axillare, Anabasis setifera* and *Salsola* spp. These species are typical of high salinity conditions and dryer, more aerated wetland soils.

2.1.3 Seagrasses

Seagrass meadows are an extensive and important ecosystem in the Arabian Gulf. There are three species in the region, *Halodule uninervis, Halophila ovalis*, *Halophila stipulacea* (Figures 1b-d). Although this represents a lower diversity compared to the eleven and seven species documented in the Red and Arabian Seas, respectively (Phillips 2003; Lipkin *et al.* 2003), the extent of this habitat is significant. Whereas only limited seagrass coverage is found in Kuwait and Iran, expansive areas of seagrass meadows are located between Qatar and the UAE. Within Abu Dhabi, an expansive complex of seagrass meadows extends around the islands and along the nearshore coastal plain. In sheltered locations these

meadows intermingle with algal beds (*Hormophysa*). The large size of the seagrass bed supports a commensurate population of Dugongs and green turtles.

2.1.4 Algal Mat

Along tidal margins of coastal sabkha where soils are consistently moist, algal mats (scientifically known as cyanobacterial mats and microbial mats) are formed by accumulation of cyanobacteria, regionally dominated by *Microcoleus chthonoplastes.* Cyanobacteria overlay laminae of bacteria, filamentous bacteria (salmon pink) and sulphur purple bacteria (purple-pink) (Kinsman and Park, 1976; Cardoso *et al., 1978*). In sheltered locations, these organisms may form a thick 'leather-like' and moist mat (Figure 1k), with a laminated fabric centimetres to tens of centimetres in thickness, and can express different surface morphologies depending on location (Kendall and Skipwith 1968). Periodic storms bring sediments to the mats leading to layering of organic and non-organic sediment. Higher in the tidal frame where evaporation is high, and in locations subject to more regular disturbance, the algal film may only be a few millimetres in thickness, covering shelly sands (Figure 1l) (Kendall and Skipwith 1968). The Abu Dhabi Blue Carbon Assessment has identified this ecosystem as a candidate Blue Carbon ecosystem.

2.1.5 Coastal Sabkha

Coastal sabkha (Figure 1e) comprises the seaward part of sabkha where it dips into the intertidal environment and mixes with patches of vegetated coastal ecosystems. Mostly it is not flooded by normal astronomical tides but can be flooded several times per year when exceptionally strong Shamal winds drive seawater inland. The coastal sabkha is largely devoid of vascular vegetation because of hypersalinity and long periods of dry conditions (Kendall *et al.* 2002). Although this ecosystem is not actively sequestering carbon, coastal sabkha often overlays former Blue Carbon ecosystems and should be measured if appropriate time and budget are available.