Blue Carbon Potential in Namibia - Blue Carbon Habitat Mapping Report

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04/12/2023 **VERSION FINAL**

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Acknowledgements

We would like to thank the many researchers and database managers who have invested years into generating and storing the myriad of resources now freely available online. Tara Pelembe (SAERI), Usman Khan (NNF) and Anja Kreiner (MFMR) provided guidance on available data sets and improved earlier drafts of this report.

Suggested Citation: Elwen, S.H. and J. Ingledew (2023) Blue Carbon Potential in Namibia - Blue Carbon Habitat Mapping Report. A report for the One Ocean Hub. Available at: The South Atlantic Environmental Research Institute (SAERI) www.south-atlantic-research.org

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*Cover photo description: Kelp (*Ecklonia maxima*) is common in shallow rocky areas of the Benguela, including the southern part of Namibia and has great promise for sequestering carbon © Simon Elwen.*

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ABOUT THE SOUTH ATLANTIC ENVIRONMENTAL RESEARCH INSTITUTE (SAERI)

SAERI was a Falkland Islands Government initiative and operated as an arm's length government department from 2012 until June 2017. From 1 July 2017, however, it became a fully-fledged and independent Charitable Incorporated Organisation (CIO) operating out of its hub in Stanley, Falkland Islands. Its origins remain a fundamental aspect to its growth and its future.

SAERI undertakes research in the UK Overseas Territories (UKOTs) and other Atlantic and Caribbean coastal communities, from the tropics down to the ice in Antarctica. Its vision is to deliver world-class environmental research that informs the effective stewardship of our planet. Its mission is to grow a sustainable environmental research institute in the Falkland Islands, and to build research and environmental stewardship capacity within and between South Atlantic Overseas Territories.

Strategically, SAERI aims to be a world-class research institute that teaches students and builds capacity within and between the South Atlantic Overseas Territories. In order to achieve that it must be:

1. Project optimised – by operating as a streamlined and efficient organisation through the Focal Areas;

2. Fully funded – Falklands registered limited company is able to fund SAERI overheads, ensuring SAERI ultimately becomes fully financially independent from Falkland Islands Government and by ensuring that all grant applications (where possible) contain cost of seat coverage; and

3. The holder of proprietary environmental knowledge of the South Atlantic – by continuing to provide the research expertise offered to date.

ABOUT THE NAMIBIA NATURE FOUNDATION

The Namibia Nature Foundation (NNF) was founded in 1987. It was initially established to help the (then) Department of Nature Conservation to raise and administer funds for the conservation of wildlife and protected area management. Since then, the work of the NNF has expanded, in both scope and volume, to encompass the whole field of environment. While considerable emphasis is still placed on the protection of parks and endangered species, the current focus of work is on broad sustainable development: environment and people, environment and development. This is seen in our work in community-based natural resource management, pollution and waste management, emphasis on policy, training and education.

The NNF works with a wide range of government organisations including the Ministry of Environment, Forest and Tourism, the Ministry of Fisheries and Marine Resources, and the Ministry of Works and Transport, and non-government organisations (e.g., IUCN, WWF, IRDNC, USAID, RSPB, SAERI, etc.). The NNF has evolved into a national institution that provides support to all relevant aspects of the environment in Namibia, to sustainable development and to wise and ethical natural resource management.

The NNF is perhaps the main NGO that has a working relationship with MFMR through projects on MPA management, inland fisheries and the Blue Economy. Along the coast, NNF and MFMR collaborate on reducing the by-catch of seabirds in the long-line fisheries and on the sustainable development of a Blue Economy. Together, the MFMR and NNF have considerable experience in the sustainable management of aquatic resources and have collaborated -thereby creating strong ties- in various projects, including currently on the development of an updated management plan for the NIMPA, which is led by NNF with the support of the Blue Marine Foundation.

Throughout past projects, NNF was engaged in several complex stakeholder engagement processes. Within the Fishery sector, it was involved in setting up the KAZA Fisheries Working Group and developing the Okavango Transboundary Management Plan. The NNF also has good connections with stakeholders involved in the development of the Sustainable Blue Economy Policy process in Namibia, not only on marine conservation but also stakeholders in maritime transport, fisheries management and coastal city municipalities.

This considerable experience coupled with a good connection with stakeholders in the marine sector, places NNF in a strong position to provide support, stakeholder engagement and facilitation for this project

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ABOUT THE ONE OCEAN HUB

The One Ocean Hub (OOH) is an international programme of research for sustainable development, working to promote fair and inclusive decision-making for a healthy ocean whereby people and planet flourish. OOH brings together coastal people, researchers, decision makers, civil society, and international organisations to value and learn from different knowledge(s) and voices. The "Hub" is funded by the UK Research and Innovation (UKRI) through the Global Challenges Research Fund (GCRF), a key component in delivering the UK Aid strategy to tackle the Sustainable Development Goals (SDGs). It addresses the challenges and opportunities of South Africa, Namibia, Ghana, and will share knowledge at regional and international levels. OOH comprises five Research Programmes (RPs):

- RP1: law, which looks at ocean governance through the lens of history, anthropology and environmental justice for multi-scale fair and inclusive governance
- RP2: arts, which explores how cultural heritage and creative responsiveness can bring stakeholders together for emotional connection with the ocean
- RP3: fisheries science in an ecosystem context, trying to understand the role of fisheries in critical marine habitats and potential impacts arising from plastic pollution and climate change
- RP4: marine sciences, focussed on advancing understanding of offshore marine biodiversity
- RP5: transformative governance for an inclusive, innovative, and responsible blue society (at a national or local level, with a focus on ethnography, economics and "empatheatre")

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1. INTRODUCTION

The aim of this work is to identify potential sources of Blue Carbon and associated Carbon Credits within Namibia including collating available information on existing and potential projects. In addition, to identify data needs and gaps, and as part of the broader project, to identify and collate relevant data and identify and engage with relevant stakeholders.

A literature review of the subject has been conducted between April and July 2023 and circulated to members of the One Ocean Hub Namibia as well as other key collaborators for input (Elwen & Pelembe 2023a). The updated report was then circulated to a broader audience of identified stakeholders. The report of that meeting is available as Elwen and Pelembe (2023b).

Blue Carbon (BC) is broadly defined to encompass 'all biologically-driven carbon fluxes and storage in marine systems that are amenable to management' (IPCC 2019). BC projects can include any areas of the ocean and adjacent shorelines, which have the potential to act as active carbon sinks and contain large stores of accumulated carbon over time scales of hundreds to thousands of years. Much of the Blue Carbon focus to date has been on coastal habitats, especially salt marshes, mangroves, and seagrass beds, but in more recent years there has be a recognition of the potential in macroalgae (kelp, Krause-Jensen & Duarte 2016). Further from shore, Blue carbon is represented in the huge amounts of carbon stored in the fauna such as cold water corals (Barnes et al. 2021), gelatinous plankton (Lebrato et al. 2013), fish (Sala et al. 2021), large whales (Pearson et al. 2023) and ultimately the benthic sediments of the open ocean (Atwood et al. 2020).

Namibia has benefited from substantial investment in research in the 21st century with significant efforts to compile those data to make them available to better manage the marine ecosystems. Notable amongst these are the marine focused efforts of the Benguela Current Commission (BCC), and its predecessor the Benguela Current Large Marine Ecosystem (BCLME), and the Marine Spatial Planning (MSP) Process (including the definition of Ecologically or Biologically Significant Areas (EBSAs)). Additionally, several other valuable resources exist including the Namibian Atlases and the privately funded Environmental Information Service which serve to collate large sets of textual, numerical and spatial data.

Due to the wide range of data sets of relevance, existence of available portals and the rapid increase of new data layers, it is not reasonable or useful to map all data layers in this document. We have taken the approach of collating key data layers (currently available in a googledrive folder internal to SAERI), which presents a list and access details for the key data repositories we have identified.

2. OBJECTIVES

The objective of this component of the Blue Carbon work was to conduct data collation and habitat mapping for Blue Carbon ecosystems to facilitate the investigation and calculation of Blue Carbon values and development of the Blue Economy within Namibia.

3. DATA

Extensive consultation and web-based searches have been conducted to identify and collate potentially valuable data sources. The majority of data is available from a few key data repositories, notably the data layers developed as part of the Marine Spatial Planning process (MFMR 2021), and the earlier BCC "BEHP" project (De Cauwer 2007) and the more recent Namibian Atlas project (Atlas of Namibia Team 2022). Key data repositories are listed in Table 1 below.

Key data repositories:

Project	Link
Static Data	These represent data sets from finished projects which are not further updated
Atlas of Namibia 2002	http://www.uni-koeln.de/sfb389/e/e1/download/atlas_namibia/e1_download_land_history_e.htm#areas_of_conservation
Atlas of Namibia 2022	https://atlasofnamibia.online/
BCC - MARISMA Project	Multiple subprojects of relevance
BCC - MARISMA – Ecologically or Biologically Significant Areas (EBSA)	https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal
IUCN Red List	Species ranges for listed species updated ~10 years. Notably sharks and marine mammals. https://www.iucnredlist.org/
Dynamic Databases	These represent ongoing, maintained and growing databases
Environmental Information Service – Namibia	http://the-eis.com/
Benguela Current Convention (BCC) – Regional Information System (RIMS)	https://www.benguelacc.org/riims-rip/
BCC – RIMS – Geoportal	Benguela Current Convention (BCC) – Regional Information System
Namibia Mines and Energy - Cadastre	https://portals.landfolio.com/namibia/
Namibia Mines and Energy – Data and publications	https://www.mme.gov.na/files/publications/4ec_Updated%20Publication%20list%202020.pdf
Substantial oceanographic and benthic data has been collected during various ship cuirses including by the:	
German vessel RV Meteor	Cruise reports here: https://www.ldf.uni-hamburg.de/en/meteor/wochenberichte.html
Much of the data from the above surveys, and others is held in the public database:	https://www.pangaea.de/
Global Carbon Datasets	https://globalcarbonatlas.org/
The Nansen Programme	The Dr Fridtjof Nansen Research vessel operated by the Norwegian Institute of Marine Research - https://www.hi.no/en
Min. Fisheries and Marine Resources	Ongoing data collection of environmental and biological parameters including fish survey counts, gelatinous planktons, temperatures, CTD profiles etc. Contact for details.
INSTAAR – DB SEABED	https://instaar.colorado.edu/~jenkinsc/dbseabed/ dbSEABED creates unified, detailed mappings of the materials that make the seafloor by efficiently integrating thousands of individual datasets.
Published datasets	Modern data sharing and open access guidelines are resulting in increasing numbers of publications making datasets available.

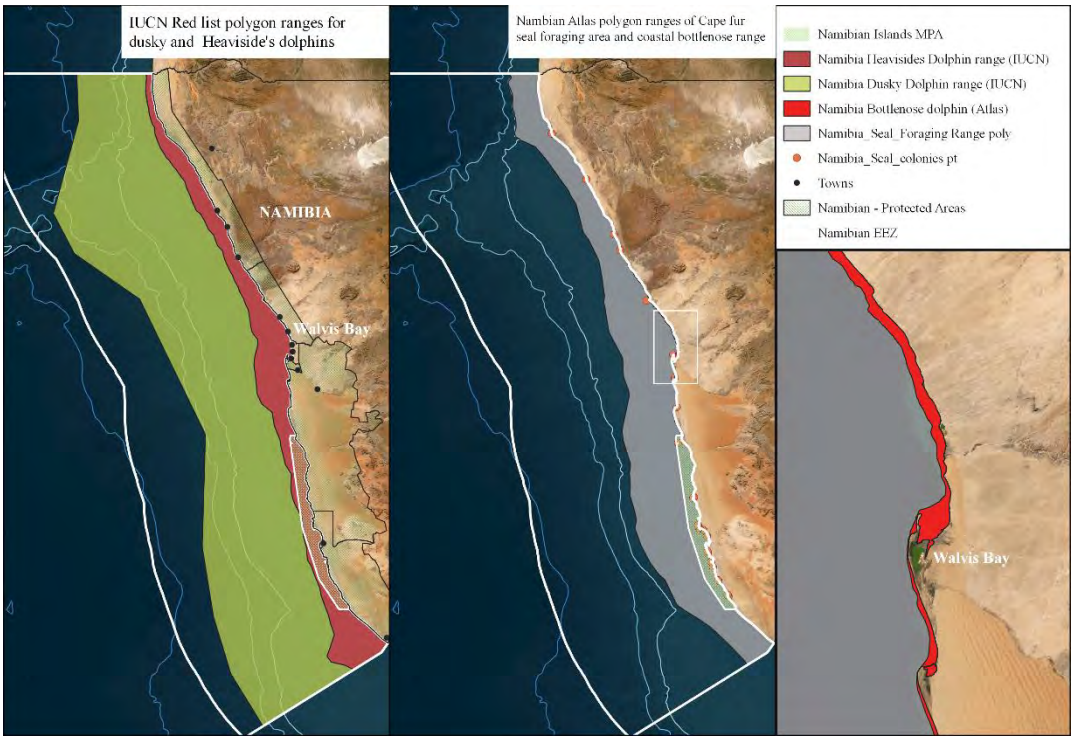
4. SUMMARY OF DATABASES AND DATA SOURCES.

In Table 1 we describe known major data sets or databases and differentiate these into those resulting from completed projects which are no longer maintained (static data sets) and those which are still being maintained as of writing and will continue to grow (dynamic datasets). Below we provide a brief description of each.

4.1. ATLAS OF NAMIBIA – 2002, 2022

The Atlas of Namibia (2022) has been written twice, with both volumes providing important information on Namibia's scenery, abundant wildlife, culturally diverse people, and natural world and climate. The more recent volume is open access and much of the data are available as shape files through The-EIS (see below). Direct link here. Although predominantly terrestrial in focus, the Atlas authors have compiled a wide range of marine data with much of it of relevance to Blue Carbon, including rivers, human population distribution and growth, ocean floor relief, marine mammal distribution amongst others.

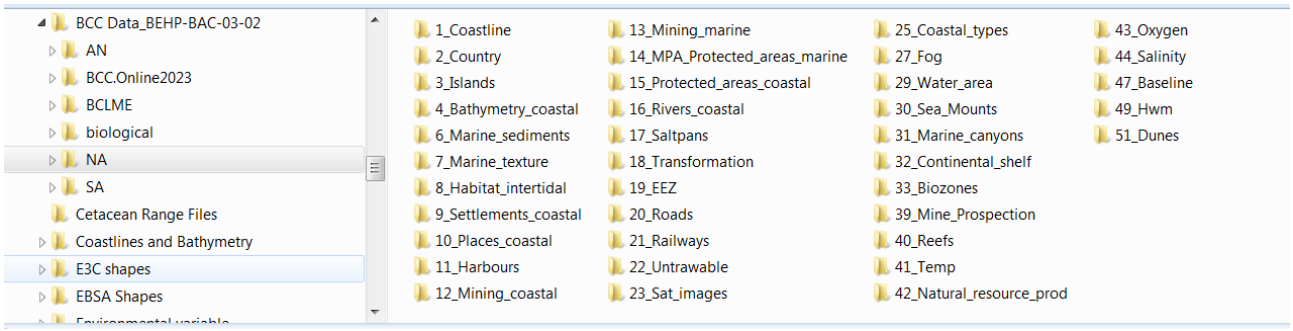
Example shape files – the range of five species of marine mammal within Namibia available through the Atlas of Namibia project 2022 and the IUCN red list (chapes oroginally produced by S. Elwen). Coastal background is ESRI Imagery data layer



4.2. BCC - MARISMA

The development of Marine Spatial Planning (MSP) in the BCLME is supported by the Benguela Current Marine Spatial Management and Governance Project (MARISMA, 2014-2023) in pursuit of the sustainable development of the Benguela Current region.

Below is a screen shot of the available data layers for Namibia from the BEHP project. These are available in the SAERI and OOH GIS data repositories



4.3. ACTIVE DATABASES

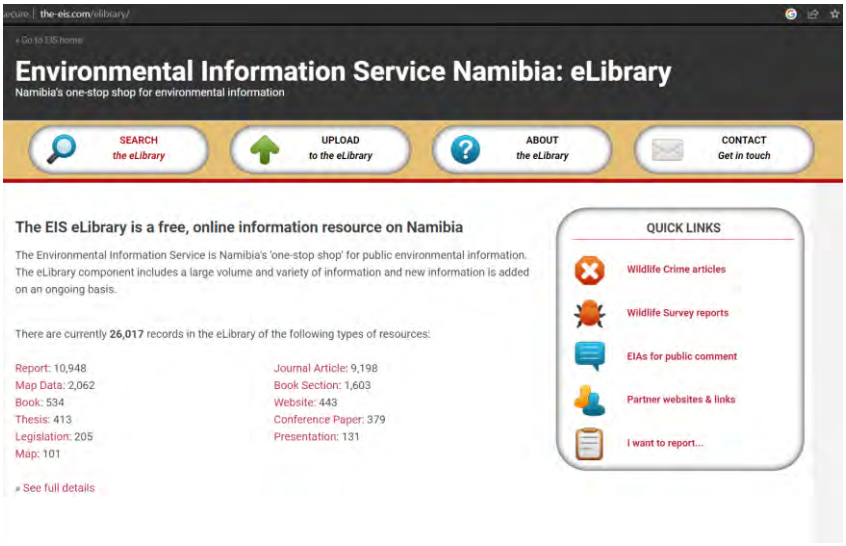
4.3.1. **The-EIS** The Environmental Information Service

Arguably the leading Namibian focused environmental database available. The EIS is The Environmental Information Service is Namibia's 'one-stop shop' for public environmental information. The eLibrary component includes a large volume and variety of information and new information is added on an ongoing basis.

The EIS contains a wide range of text, numerical and spatial and photographic data including scientific publications of relevance, reports from projects and NPOs, conference papers, raw data including several 'Atlasing' initiatives (birds, amphibians, butterflies etc), access to the Atlas of Namibia (see above) and map data.

In late September 2023 the website lists the following content:

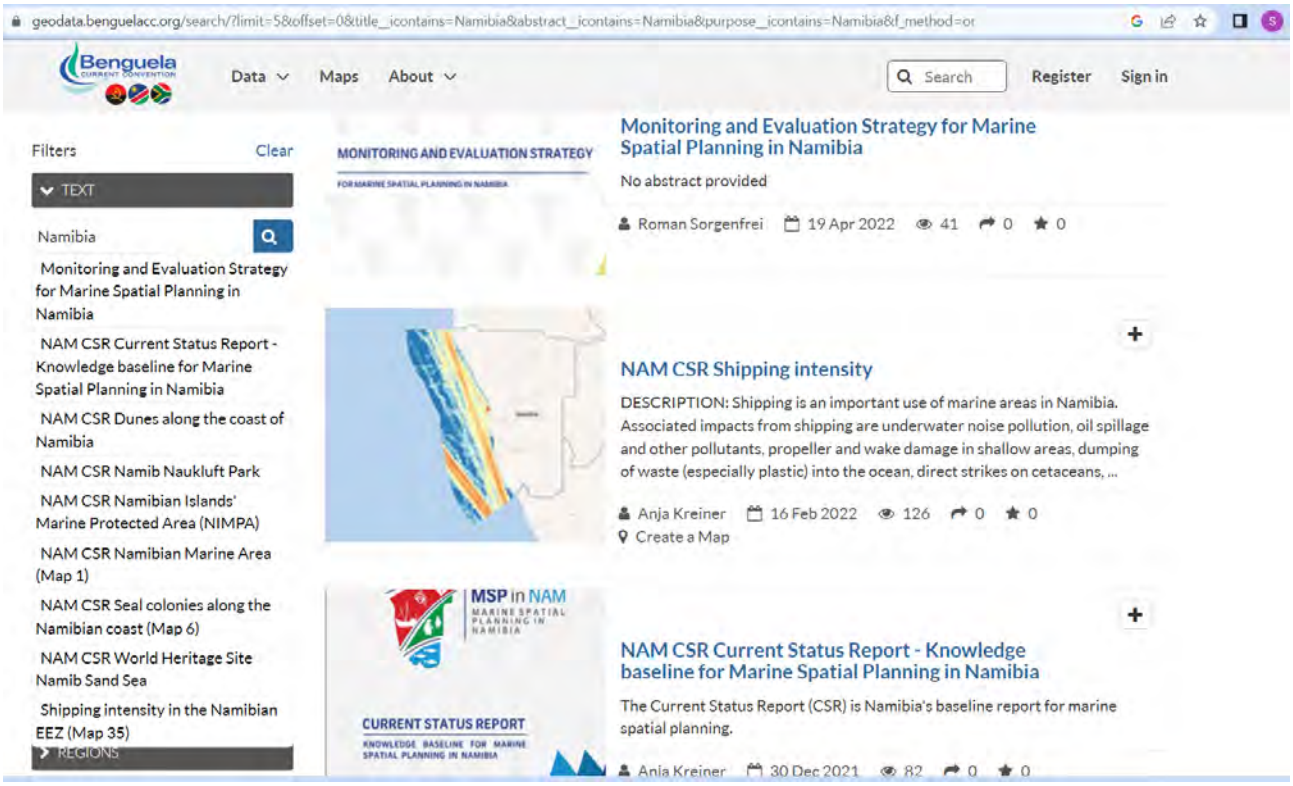
There are currently **25,986** records in the eLibrary of the following types of resources: Report: 10,935 / Journal Article: 9,188 / Map Data: 2,062 / Book Section: 1,601 / Book: 534 / Website: 443 / Thesis: 407 / Conference Paper: 379 / Legislation: 205 / Presentation: 131 / Map: 101



4.3.2. Benguela Current Convention (BCC) – Regional Information System (RIMS) and Geoportal

The RIMS Geoportal has been built and maintained by the Benguela Current Commission with the goal of long-term data storage of relevance to the member states (Angola, Namibia, South Africa). Data are managed by the Data and Information Manager who is responsible for the compilation, coordination, and distribution of data and information necessary for the functioning of the Benguela Current Commission.

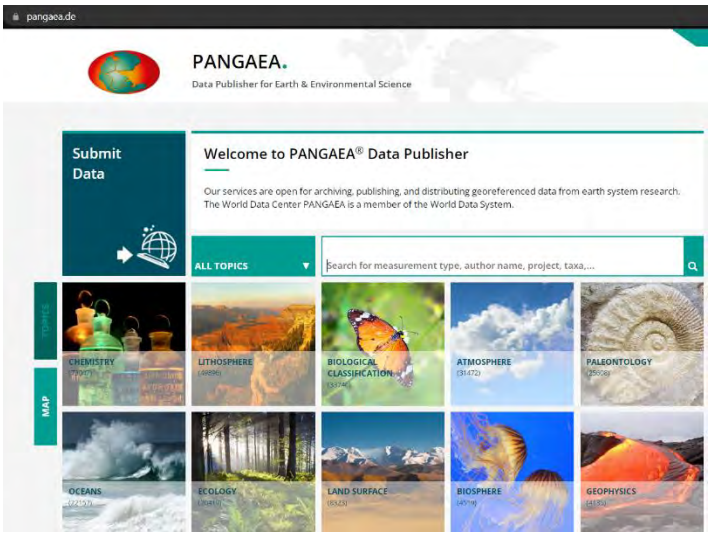
It is not currently possible to download a list of all files (a request has been made to the BCC Data manager), but a search for “Nam*” reveals 37 data layers as of September 2023.



4.3.3. Pangea database

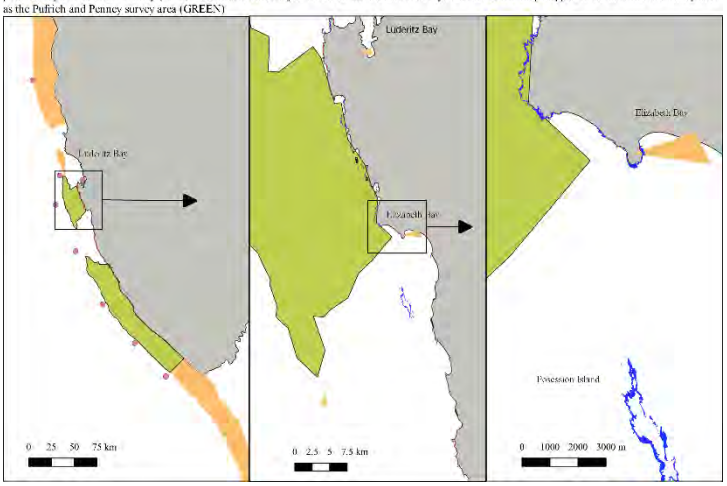
PANGAEA is operated as an Open Access library aimed at archiving, publishing and distributing georeferenced data from earth system research. PANGAEA guarantees long-term availability (greater than 10 years) of its content. PANGAEA is open to any project, institution, or individual scientist to use or to archive and publish data. Of relevance to Namibia – this database hosts the cruise and data reports for surveys conducted by the RV Meteor (a survey vessel owned and operated by the German state and represented by the Federal Ministry of Education and Research) which has conducted multiple cruises in or adjacent to Namibian territorial waters.

The Pangea database thus holds a wide range of data from raw cruise reports to peer reviewed publications. Some examples of relevance to Blue Carbon include:
Emeis, Kay-Christian (2015): Suspended matter from METEOR cruise M76/2 in the Benguela Upwelling System off Namibia in May 2008. Institute of Geology, Biogeochemistry, University of Hamburg, PANGAEA, https://doi.org/10.1594/PANGAEA.854073 *Jacot des Combes, H; Abelmann, A (2007): Radiolarian fauna of sediment core MD96-2089 off Lüderitz, Namibia* *Niewöhner, C; Hensen, C; Kasten, S et al. (1998): Methane and hydrogen sulfide in porewater of sediment cores from the upwelling area off Namibia* *Tamborrino, Leonardo; Hebbeln, Dierk (2023): Cold-water coral mounds peaks off on the northern Namibia shelf. PANGAEA, https://doi.org/10.1594/PANGAEA.956090* *Vinogradova, NG; Levitan, MA; Galkin, SV et al. (1990): (Table 1) Bottom fauna Metazoa in grab samples from the Namibia shelf in the area of Benguela upwelling*



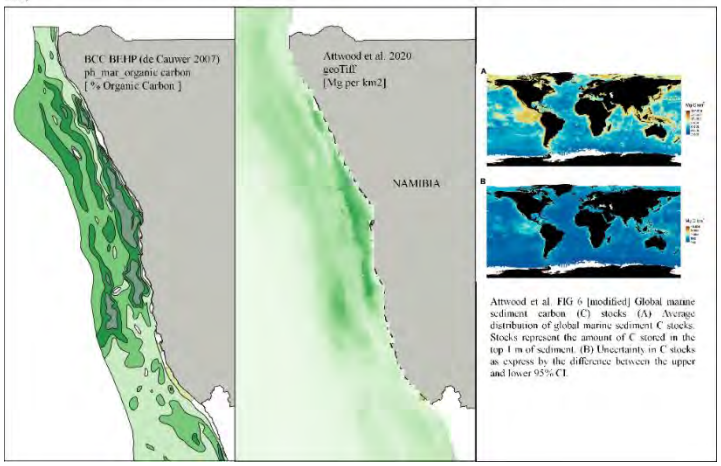
4.4. OPEN ACCESS PUBLISHED DATA SETS:

Modern data sharing and open access guidelines are resulting in increasing numbers of publications making datasets available, some of which include locally generated data, others are extrapolated. Subsequently – the quality of these datasets can vary widely in their accuracy in comparison to in-situ datasets available within Namibia and wherever possible, users should ground truth data. Below we provide two examples:



Example map of modelled Kelp distribution from UNEP (ORANGE - based on Jayathilake & Costello, 2020), and detailed kelp mapping (BLUE) produced by Pulfrich and Penney (2006) for a DebMarine Project based off in situ aerial surveys and the UNEP map clipped in to the same the survey area as the Pulfrich and Penney survey area (GREEN)

The first is a comparison of a globally generated macro-algae habitat map generated by (Jayathilake & Costello 2020) from data available in the GBIF database and available here with raw data here. This data was used by Khan et al. (2022) in a first attempt to provide an economic evaluation of macroalgae within Namibia as a local data set is not available for the whole country. In our associated review of Blue Carbon Potential within Namibia (Elwen & Pelembe 2023a) – we compare this data set with a in situ aerial data of kelp distribution available from a study of a portion of southern Namibia (Pulfrich & Penney 2006). In this case – the two data sets do NOT COMPARE WELL as there is a difference of two orders of magnitude between true kelp habitat and 'potential habitat' projected at a global scale (UNEP modelled area = 4365 km^2, calculation from aerial survey: 4.53 km^2).



Comparison of datalayers avaiable from the local sources (MFMR - BCC BEHP project, and a recent globally generated dataset (Attwood et al. 2020). Imageson right are taken rom the Attwood paper and show the same data setat it's global extent as well as the error layer (not high undertinaty in Namibian EEZ)

The second example is benthic carbon resources. A 'local' data layer on percent organic carbon in sediments is available through the BCC BEHP project (de Cauwer 2007) and a global data layer of Mg carbon km^2 is available from Attwood et al. 2020, which uses data points from a wide range of sources including Google Scholar, Web of Science, Pangea, personal datasets, and published reports, which include multiples measured points from Namibia. in this case – the data sets COMPARE VERY WELL with the same areas of high and low concentrations highlighted in both maps.

5. CONCLUSION

Blue Carbon research and investment is reliant on multiple types of data from multiple sources from spatial to legal, and climate change trends to anthropological. It is not possible to capture all data sources for all possible projects but we have attempted here to provide a useful overview of several key global and Namibian databases of relevance.

There is a strong push globally to make data open access and this is clearly reflected in the growing number of libraries and resources available.

As part of the project work with the One Ocean Hub, SAERI have collected an online database of available geospatial data (mainly shape and raster files) that has been generated by multiple projects within Namibia e.g. EBSA, MSP, Atlas which can be made available through SAERI or the NNF geodata manager.

Reference list:

Atwood TB, Witt A, Mayorga J, Hammill E, Sala E 2020 Global Patterns in Marine Sediment Carbon Stocks. Front Mar Sci 7:1–9

Barnes DKA, Bell JB, Bridges AE, Ireland L, Howell KL, Martin SM, Sands CJ, Soto AM, Souster T, Flint G, Morley SA 2021 Climate mitigation through biological conservation: Extensive and valuable blue carbon natural capital in tristan da cunha's giant marine protected zone. Biology (Basel) 10

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Sala E, Mayorga J, Bradley D, Cabral RB, Atwood TB, Auber A, Cheung W, Costello C, Ferretti F, Friedlander AM, Gaines SD, Garilao C, Goodell W, Halpern BS, Hinson A, Kaschner K, Kesner-Reyes K, Leprieur F, McGowan J, Morgan LE, Mouillot D, Palacios-Abrantes J, Possingham HP, Rechberger KD, Worm B, Lubchenco J 2021 Protecting the global ocean for biodiversity, food and climate. Nature 592:E25

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