Notes

# STATE OF HYDROGRAPHY SURVEY IN KENYA TOWARDS HYDROSPATIAL DATA INFRASTRUCTURE

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## INTRODUCTION

This article focuses on the current status of hydrographic efforts in Kenya, as well as, the future plans to develop foundational hydrographic elements and layers of data and information towards the implementation of the Kenya hydrospatial data information. "Hydrospatial is all about the Blue of our Blue Planet and its Coastal Zones" (Hains D. & HMCC members 2021). Hydrospatial could be described as that portion of geospatial knowledge infrastructure that addresses the hydrosphere (Smits 2021). Hydrospatial is an expansion of Hydrography and it is a much broader domain. (Hains & al. 2021; 2020; Pang & Oie 2020 + Ponce 2019).


***Figure 2:*** *Kenya location on the World Map. Copyright © Ontheworldmap.com https://ontheworldmap.com/kenya/kenya-location-map.html*

On 26th July 1991 the Cabinet approved the establishment of a National Hydrographic Office under Survey of Kenya (SoK) in the Ministry of Lands and the Kenya National Hydrographic and Oceanographic Committee (KNHOC) currently known as the Kenya National Hydrographic and Oceanographic Committee (KeNHOC) which became operational in January 2006. KeNHOC is mandated to spearhead coordination of hydrographic services in all different government Ministries, Departments and Agencies (MDAs) in the country among other responsibilities and its members are drawn from key government institutions offering maritime and hydrographic services. The members include Survey of Kenya as the secretariat, Kenya Navy (KN), Kenya Ports Authority (KPA), Kenya Maritime Authority (KMA),

Kenya Marine and Fisheries Research Institute (KMFRI), University of Nairobi (UON), Regional Center for Mapping and Resource Development (RCMRD), Kenya International Boundary Office (KIBO), NationalOil Corporation Kenya (NOCK), Kenya Coast Guard Service (KCGS), National Environment Management Authority (NEMA) and the Kenya Ferry Service (KFS).

Kenya is endowed with a coastline that stretches approximately 536 km of the Indian Ocean, Lake Victoria; the 2nd largest freshwater lake in the world, eight major lakes along the rift valley and several dams for hydro-electric power production. The Kenyan Exclusive Economic Zone (EEZ) covers approximately 142,000 km$^2$ with potential extension of its continental shelf beyond the 200nm by approximately 103,302 km$^2$ from a continental shelf survey that was done in 2007. Kenya made its proclamation of the EEZ in February 1979 through a Presidential Proclamation and was revised in 2005 and published by the United Nations (UN), territorial boundary delimited in 1972 and her continental shelf was delineated and a submission (https://www.un.org/depts/los/clcs_new/submissions_files/ken35_09/ken2009_executivesummary.pdf) on the continental shelf beyond 200 nautical miles was deposited to Commission on the Limits of the Continental Shelf (CLCS) in the year 2009 which is currently undergoing examination by the Commission

Kenya has three major ports: Port of Mombasa, Kisumu Port and the newly launched Lamu Port. Lamu Port is part of Lamu Port Southern Sudan Ethiopia Transport Corridor (LAPSSET), a Vision 2030 mega infrastructure project connecting Eastern Africa countries. Shimoni Port is under construction besides various fishing ports along the Indian Ocean and Lake Victoria. With all these resources, a base map is needed for hydrospatial data infrastructure including physical, biological and chemical data and information in the water domain; marine spatial planning, maritime boundary delineation and resource exploration and exploitation which requires a foundational bathymetric data layer from hydrographic surveys. With the rapid growth in technological advancement, especially in data collection and processing there is need to locally define procedures for data collection, processing, quality control and assurance locally and data archival as per IHO standards, to meet accuracy and interoperability requirements for charting purposes.

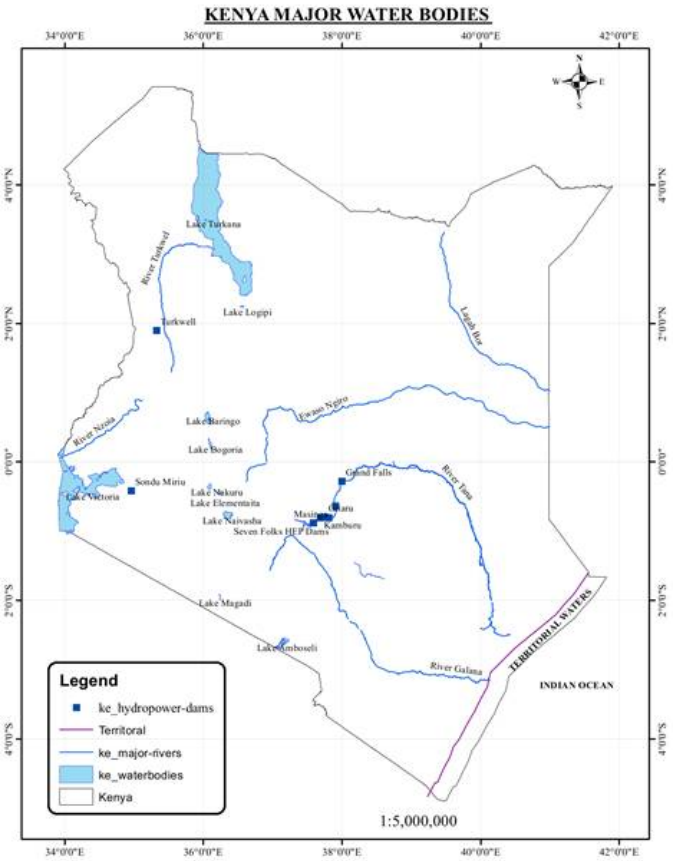


***Figure 4:*** *Map showing locations of Kenya's major lakes, rivers and dams*

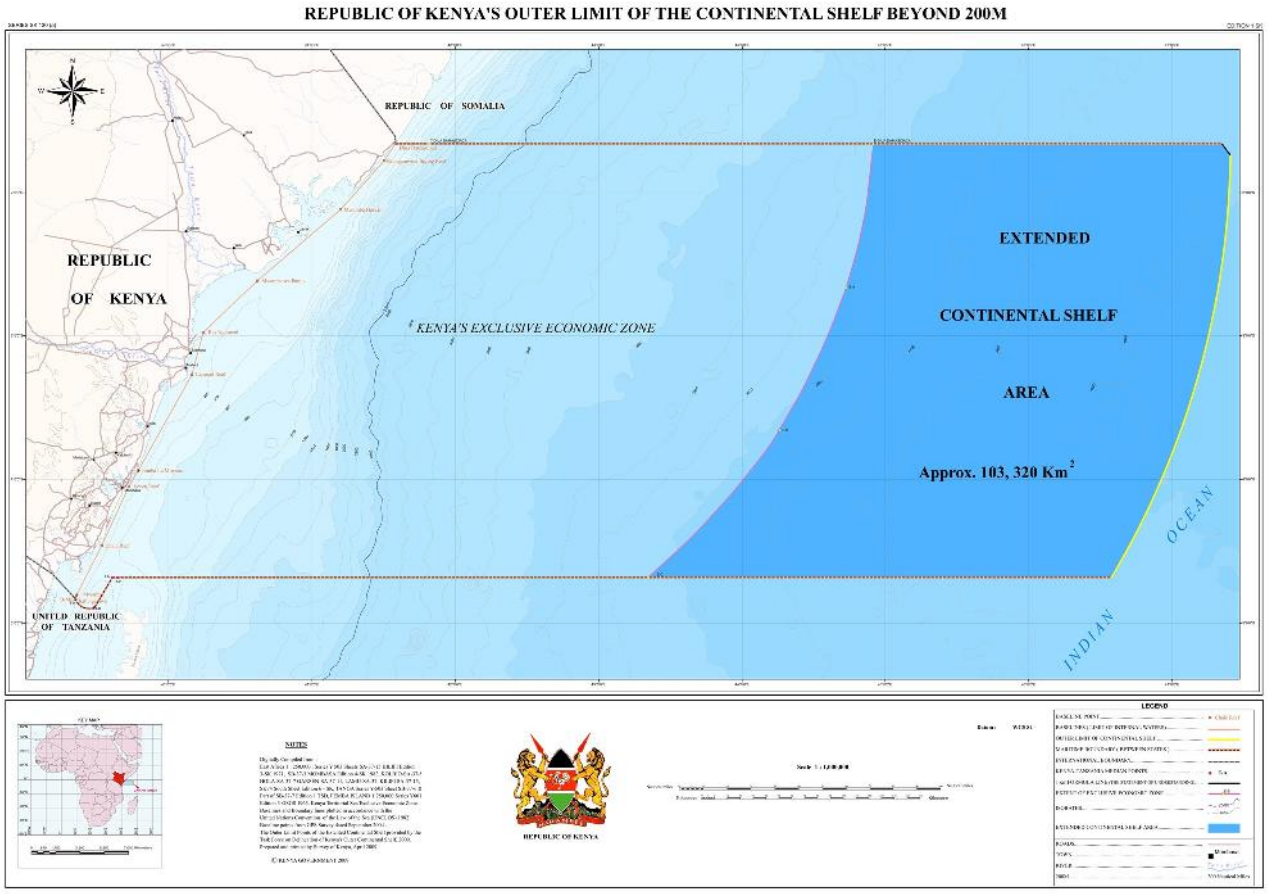


***Figure 5:*** *Map Showing the Exclusive Economic Zone and Extended Continental Shelf*

South Africa, Nigeria and Mauritius have successfully invested in hydrographic surveying, especially in human resource capacity development, such that they carry out hydrography surveys alongside production of nautical charts with very little help from other organizations. In the Kenyan context, it is a gateway to landlocked east and central African countries and is positioned midway between the Gulf of Aden and South Africa. Therefore, hydrography is very crucial, especially on the issues of safety of navigation and maritime boundary claims, since Kenya is a state party to the Safety of Life at Sea (SOLAS) Convention and is required to ensure that appropriate paper charts and Electronic Navigation Charts (ENCs) are available in accordance with Regulations 9 and 4 of Chapter V of that Convention and United Nations Convention on the Law of the Sea (UNCLOS). Dredging and expansion of ports and harbors, oil and gas offshore production prospects and improvement of lake transport are major projects earmarked for funding towards the realization of the blue economy agenda that includes hydrospatial data and information in a multidimensional context.

## THE KENYA NATIONAL HYDROGRAPHIC OFFICE (KNHO)

The United Kingdom Hydrographic Office (UKHO) is the Primary Charting Authority that does publication, maintenance and distribution of all Admiralty nautical charts (paper, raster and electronic charts) and nautical publications (list of light, radio signals, sailing directions, tide tables) on behalf of Kenya. The Kenya National Hydrographic Office currently has one Category (CAT) A hydrographer, seven CAT B hydrographers and one CAT B nautical cartographer. The Kenya Ports Authority and Kenya Marine and Fisheries Research Institute each have one CAT A hydrographer while the Kenya Navy has twelve CAT B hydrographers.

The hydrographic survey section has three offices; Nairobi office is the headquarters; the Mombasa regional office is in charge of the coastal province covering the Indian Ocean, while the Kisumu office is in charge of all activities on and along Lake. Victoria region. The Hydrographic survey section in Survey of Kenya (SoK) is equipped with a Knudsen Single beam Echosounder, RTK GPS Base Station without rover, four portable tide gauges and a recently acquired survey launch that must still be prepared for work.

The Kenya Marine Fisheries and Research Institute (KMFRI) produces tide tables, but due to differences between the data and the predictions in the Admiralty Tide Tables, Kenya Maritime Authority (KMA), the authorized maritime regulatory body, only recognizes the Admiralty Tide Tables as the official product for use in Kenyan waters. Permanent recording tide gauges are installed at: Kenya Port Authority in Mombasa, one each in Lamu and Kilindini Harbour, which were donated in 1986 through Intergovernmental Oceanographic Commission of the United Nations Education, Scientific and Cultural Organization (IOC- UNESCO) and monitored by the University of Hawaii as part of Global Sea Level Observing System network. Kenya Meteorological Department (KMD) has four gauges dispersed as follows: one in Lamu, Mombasa, Shimoni and Malindi which are mainly for tsunami early warning, salinity and conductivity measurement.

KMFRI also has a research vessel, RV-MTAFITI (currently the main research vessel in Kenya), which was donated by the Belgium Government in 2014. Several cruises have been conducted but mainly on biological and physical oceanography expeditions. Members from different government agencies have taken part in various cruises in data collection that fits their specific use.


***Figure 6:*** *The Kenya Marine Fisheries and Research Institute; Research Vessel MTAFITI.*

KNHO Challenges and Opportunities

a. Challenges

i. More coordination is needed between hydrospatial stakeholders, state agencies and other corporations;

ii. The level of hydrography awareness is very low in Kenya;

iii. There are currently no institutions in Africa offering Category A (Professional) or Category B (Technologists) training in hydrography;

iv. Presence of Piracy in the Western Indian Ocean region around the horn of Africa;

v. High cost of equipment (e.g. Research Vessel, Echo sounders, Motion sensors, CTD, ADCP, etc.);

vi. Inadequate scientific and technical capacity in expertise, research and innovation to implement hydrography surveys;

vii. Scarcity in capacity-building and technology transfer;

viii. Little or no data sharing by data producers.

b. Opportunities

i. There are many hydrographic and hydrospatial assets at the disposal of the government that, with national effort and proper coordination, can result to maximum value gain;

ii. Apply for training for the Marine Spatial Infrastructure (MSI) Coordinator under IHO Capacity Building;

iii. As the youngest IHO member, Kenya can apply for the short-term assistance of an established hydrographic office to develop a robust National Hydrographic Structure for Kenya;

iv. Kenya has very strong institutions with resourceful personnel who are recognized on a global scale for the work they are doing for our oceans. Their diversity of different backgrounds should be used as a strength towards integration, which will result in stronger institutional frameworks.

v. Cross-governmental coordination to ensure 'collect once use many times.'

## CURRENT AND UPCOMING PLANS

Kenya is proud to be the 95th member of the International Hydrography Organization. The benefits that come with the status include training opportunities, becoming members of different committees; sub-committees; Regional Hydrographic Commissions; technical working groups that set standards, seeking and providing technical advice and support on hydrographic developments besides establishing collaborative international projects.

***Figure 7:*** *Thumbnail image of the IHO Circular Letter 24/2021 01 July 2021 (https://iho.int/uploads/user/circular_letters/eng_2021/CL24_2021_EN_v1.pdf )*

The Somali maritime boundary claim that is before the International Court of Justice (ICJ) has raised a lot of debate regionally and internationally. Detailed hydrographic survey data on positions and delineation forms part of submission that the courts rely on. The Western Indian Ocean Marine Science Association (WIOMSA) together with the Nairobi convention has been holding meetings and deliberations concerning marine spatial planning which is concerned with much more than Hydrography and corresponds to the strategic intent of creating Hydrospatial Data Infrastructure. This responds to the FAIR principles of being: FINDABLE, ACCESSIBLE, INTEROPERABLE and REUSABLE data and information.

Through the International Oceanographic Commission (IOC)'s Ocean Teacher Global Academy (OTGA), KMFRI has been conducting courses on marine spatial planning among other ocean sciences courses. The introduction of fundamentals of ocean mapping as one of the key courses in the program will help improve the understanding of the relationship between ocean mapping and other marine fields since "Hydrographic data is the foundation layer that all maritime data hangs off".

There are future plans towards development of the seven small ports along the Indian Ocean, which will include modernization and expansion of port facilities, dredging, benchmarking of facilities and services with international best practices and standards. The ports, Funzi, Shimoni and Vanga located in the south coast, Mtwapa, Kilifi, Malindi, and Kiunga located north of Mombasa, were earmarked for development under Kenya's Vision 2030 flagship project that translates to a boost in the blue economy. This therefore, means hydrographic surveys need to be carried out with many more hydrospatial data and information requirements.

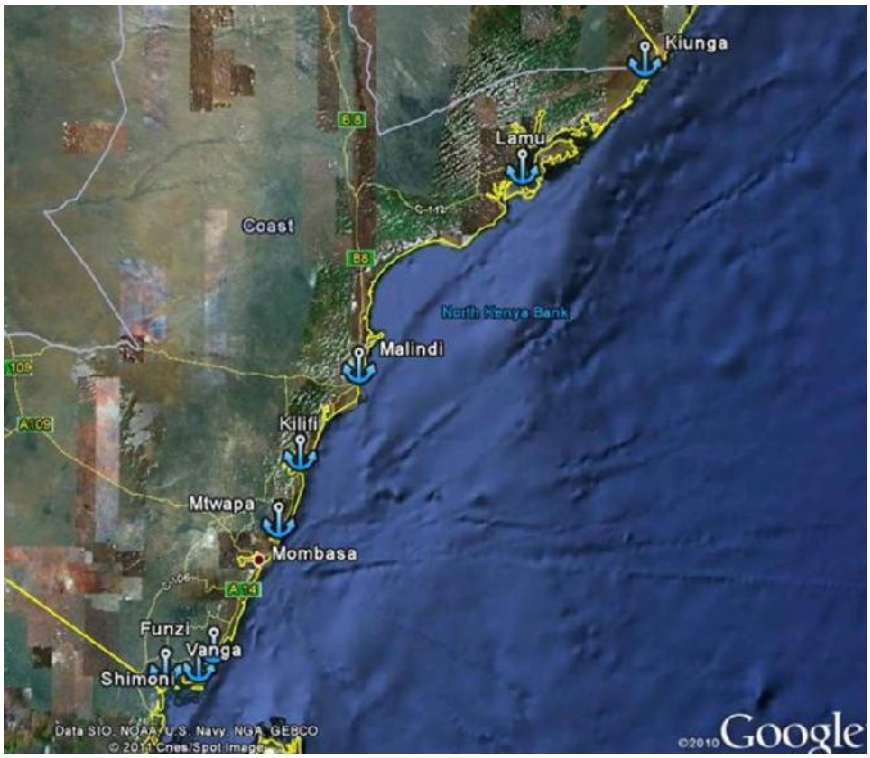


***Figure 8:*** *Kenya Ports including seven small ports earmarked for development*

## THE FUTURE

In order for marine and aquatic data and information gathered from around the world to be used by all ocean stakeholders, the digital uniformity of this data is crucial. The S-100 universal data model framework by IHO is set to bridge the gap by offering standards and formats for data gathered from a variety of disciplines operating on the maritime domain. This ensures that data

can easily be exchanged among stakeholders operating in the maritime domain. This premise is the basis upon which, going into the future, the country's maritime stakeholders have to cooperate and work together in order to advance the international and national obligation of provision of hydrographic services to mariners.

Due to the development of hydrographic technology, the questions currently have shifted from what the ocean floor looks like to what is in the water leading to an exponential increase of the use of marine and aquatic data and information. Marine Spatial Data is being used to make informed decisions that contribute to sustainable use of the seas.

a. Data and information collected once will respect the FAIR principles to be used many times and the quantity and variety is set to increase significantly with more multi-spectrum data being collected across a broader range of environments from a broader range of sensors employing more autonomous collection methods. Although, as a nation, these systems seem far off, development of capacity, albeit in little steps, is key if we are going to advance in this discipline of hydrography towards hydrospatial for the benefit of the Kenyan people.

b. Change detection and forecasting will improve with increased repeat surveys being an outcome of the use of more autonomous collection methods by satellite, air, land, water and therefore reducing the number of people in the field, at sea and increasing efficiency and effectiveness of data collection. Change detection and forecasting will enable better management of ocean resources for sustainability.

c. The increased volumes of collected data and information will spur innovative methods of data processing. This will result in the increase of the use of the cloud and artificial intelligence in processing of data in near real time. Innovation. in the form of complex algorithms to process the collected data and information, will be a key enabler of hydrographic surveys going forward in Kenya towards hydrospatial.

d. Time spent by the human element to collect and process hydrographic data will tremendously reduce and therefore more time will be spent in analyzing and interpreting data to transform it into actionable information. Therefore, the skills required in the hydrographic and hydrospatial sphere will change creating demand for new training and providing new career opportunities. The opportunities presented in the discipline of hydrography in Kenya are immense considering the current inadequacy of expertise in the field and the need to explore and exploit the oceans and aquatic resources under hydrospatial for the Blue Economy banner.

## BLUE ECONOMY

The opportunities presented by the blue economy as sited in the African Union Agenda 2063 https://au.int/sites/default/files/newsevents/conceptnotes/27474-cn-concept_note_eng_0.pdf and Kenya's Vision 2030 http://www.xinhuanet.com/english/2020-12/04/c_139561773.htm are Africa's next frontier. The Kenyan government created the Blue Economy Task Force in 2017 to play an important role in Development of Policy and Strategies to help harness the benefits of the Blue Economy.

So far, Germany, Portugal, France and Italy from the European union have partnered with six coastal counties in Kenya "Jumuiya ya Kaunti za Pwani" namely Mombasa, Kwale, Kilifi, Tana River, Lamu and Taita Taveta under the banner Go Blue Initiative on March 25, 2021. Go Blue Initiative is a four year program that aims to provide technical expertise on economic growth. United Nations Environment Programme (UNEP) and UN-Habitat came on board to ensure environmental conservation of natural resources and biodiversity and urban planning for socio economic balance. The key components of the blue economy are recycling, tourism, small-scale fishing, maritime transport and security, oil and mineral exploitation, spatial land-sea planning and environmental conservation and climate change geared towards a sustainable Blue Economy under Sustainable Development Goal 14 (SDG14).

## CONCLUSION

A well-defined hydrospatial infrastructure, defined as "the branch of applied sciences which deals with the analysis, understanding and access to static and dynamic marine geospatial digital and analog data and information, digital signals, measurement and description of the physical, biological and chemical features of oceans, seas, coastal areas, lakes and rivers from all possible available data sources in near-real time, real-time, including history and the prediction of their change over time for the purpose of providing timely access to standard, quality and the most up-to-date marine spatial data infrastructure, including the safety and efficiency of navigation; aquatic and marine activities, for a sustainable Blue environment & economic development, security and defense, and scientific research," supports the three major actions of the United Nations Decade of Ocean Science. A hydrospatial infrastructure will realize: A transparent and accessible ocean whereby all nations, stakeholders and citizens have access to ocean data and information technologies and have the capacities to inform their decisions. A healthy and resilient ocean whereby marine ecosystems are mapped and protected, multiple impacts, including climate change, are measured and reduced, and provision of ocean ecosystem services is maintained. A predicted ocean whereby society has the capacity to understand current and future ocean conditions, and forecast their change and impact on human well-being and livelihoods.

## REFERENCES

Hains D.; Ponce R.; Oei P; Ghülher E.; Pang P.Y.; Cove K.; Cawthra H.C.; Bergmann M.; Picard K. – International Hydrographic Review, No. 25, May 2021 – **So… What is Hydrospatial?** Pp. 115-122 https://iho.int/uploads/user/pubs/ihreview_P1/IHR_May_2021.pdf

Hains D. – International Hydrographic Review, No 23, May 2020 – **What is Hydrospatial?** Pp. 84 -93 https://iho.int/uploads/user/pubs/ihreview_P1/IHR_May2020.pdf

Pang P. Y. & Oei P – International Hydrographic Review No 24, November 2020 – **Singapore's National Marine Spatial Data Infrastructure "GeoSpace-Sea": Enabling Hydrospatial Context and Applications in a Changing Ocean and Seascape.** Pp. 21-36 https://iho.int/uploads/user/pubs/ihreview_P1/IHR_November2020.pdf

Ponce R – International Hydrographic Review, No 22, November 2019 – **Multidimensional Marine Data: The nest frontier for Hydrographic Offices.** Pp 55-70 https://iho.int/uploads/user/pubs/ihreview_P1/IHR_Nov2019.pdf

Smits M. – Hydro International Magazine, June 2021 – **Hydrospatial Technology: Collaboration Expanding Globally to Address Escalating Needs**

https://www.hydro-international.com/content/article/hydrospatial-technology-collaboration-expanding-globally-to-address-escalating-needs

Review of near-shore satellite derived bathymetry: classification and account of five decades of coastal bathymetry research Accessed 9 March 2021 https://www.sciencedirect.com/science/article/pii/S2468013321000218

https://iho.int/mtg_docs/rhc/SAIHC/SAIHC15/SAIHC15-11.2K_NationalReport_Kenya.pdf Accessed 13 April 2021

http://www.vliz.be/kenya/sites/vliz.be.kenya/files/public/KMFRIdocuments/Charles%20Magori.pdf Accessed 24 May 2021

http://www.parliament.go.ke/sites/default/files/202011/Report%20on%20the%20Accession%20to%20the%20Convention%20on%20the%20International%20Hydrographic%20Organisation%20%28IHO%29%20by%20the%20Republic%20of%20Kenya%20%20DC%20Defence%20and%20Foreign%20Relations.pdf Accessed 24 May 2021

https://www.rcmrd.org/about-us/what-we-do Accessed 24 May 2021

https://www.unep.org/news-and-stories/story/new-programme-support-kenyas-coast-and-blue-economy Accessed 7 June 2021

https://au.int/sites/default/files/newsevents/conceptnotes/27474-cn-concept_note_eng_0.pdf Accessed 4 July 2021

http://www.xinhuanet.com/english/2020-12/04/c_139561773.htm Accessed 4 July 2021