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Enhancing Ocean Observations in the Western Indian Ocean region

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IOC Sub Commission for Africa & the Adjacent Island States

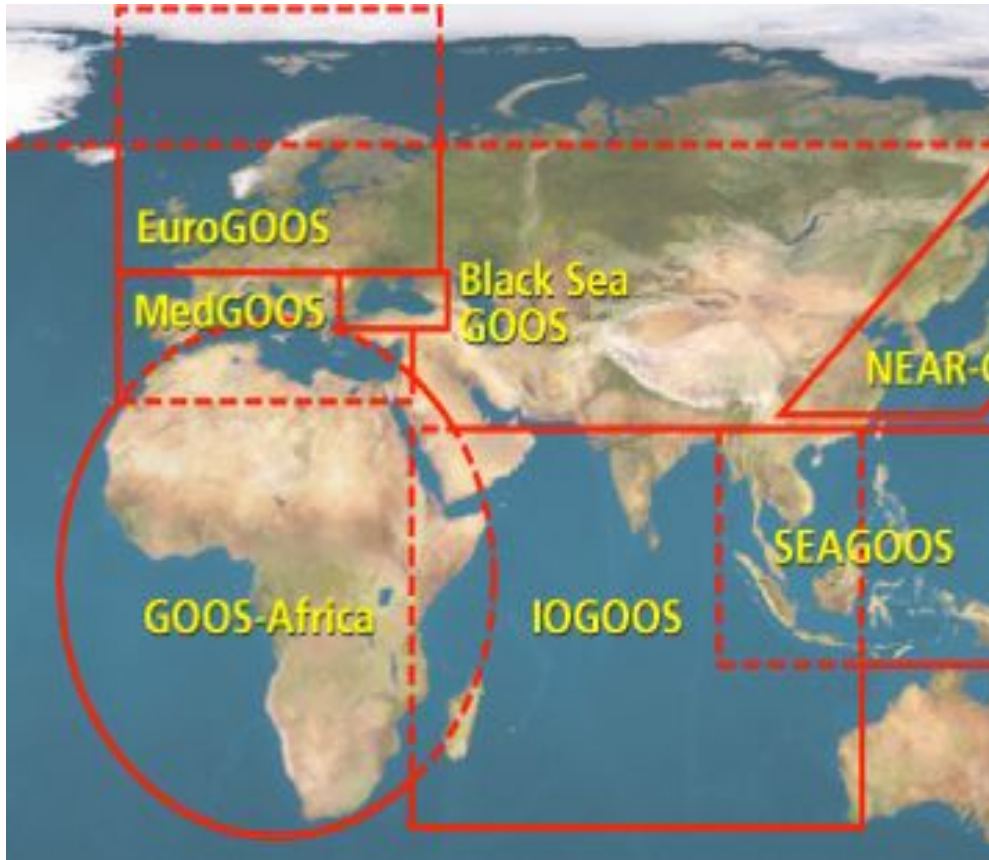
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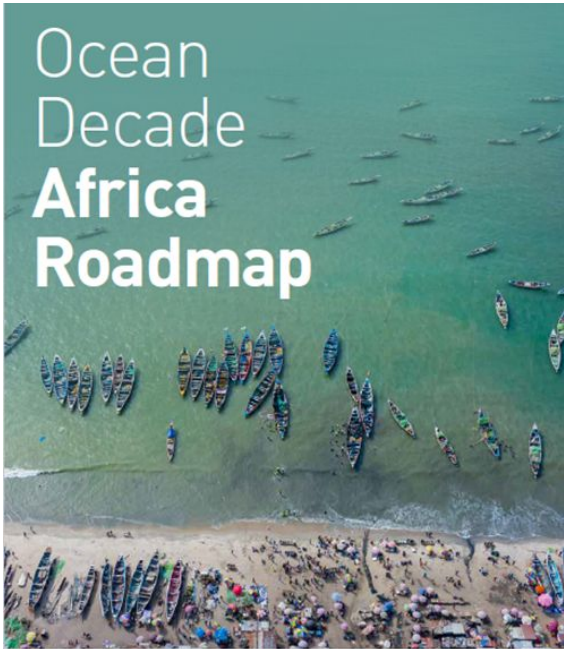
- Societal and scientific priorities
- Regional proposals for Ocean Observations
- Highlights of Ocean Observations in the region
- Gaps that need to be addressed



IOCAFRICA REFLECTIONS.

A reliable and functional ocean observation system that is able to provide ocean information (products) for human security and sustainable economic development in Africa and the adjacent Island States..











1. Food Security and Fisheries
2. Early Warning for ocean related hazards and disaster risk reduction
3. Ecosystem services and sustainability
4. Coastal management and governance
5. Climate Variability/ Change and adaptation
6. Higher Education and training



Ocean Decade Africa Roadmap

The United Nations Decade of Ocean Science for Sustainable Development 2021-2030



-  **Pollutants**
-  **Ecosystems**
-  **Food from the Ocean**
-  **Ocean economy**
-  **Ocean-climate nexus**
-  **Ocean-related risks**
-  **Ocean observing system**
-  **Ocean digital representation**
-  **Capacity development**
-  **Behaviour change**

IIOE-2 Science and societal drivers.



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Geological Science Drivers:

- 1) Plate tectonics – triple junction, complex and active spreading centers
- 2) Hydrothermal vents and their Impacts on deep ocean chemical distributions and life forms
- 3) Sediment sources, transport, deposition and diagenesis
- 4) Mineral deposits
- 5) Earthquakes/Tsunamis and volcanic eruptions

Physical Oceanography and Atmospheric Science Drivers:

- 1) General circulation and its influence on biogeochemistry and ecology
- 2) Boundary current dynamics and upwelling variability
- 3) Monsoon variability and predictability
- 4) Extreme events
- 5) Climate variability and change

Biogeochemical and Ecosystem Science Drivers:

- 1) Ocean stressors (warming, deoxygenation, acidification, eutrophication, atmospheric & plastic pollution, coastal erosion and overfishing)
- 2) Biodiversity loss, changes in phenology and biogeography
- 3) The Indian Oceans role in the global nitrogen and carbon cycles
- 4) Fisheries: recruitment, productivity and links to biogeochemistry and physics

Societal Drivers:

- 1) Food security and fisheries (commercial and subsistence, overfishing)
- 2) Change in coastal environments (sea level rise, coastal erosion, loss of mangroves)
- 3) Human impacts of climate change, extreme events and monsoon variability
- 4) Biodiversity loss and ecosystem conservation for fisheries, tourism, and general well-being



WIO PRIORITY TOPICS FOR IIOE-2

1. Habitat mapping and living resources inventory
2. Connectivity and genetics
3. Air-sea interactions, climate variability and extreme events such as cyclones and storm surges
4. Geology – structural features of the WIO seabed
5. coastal and shelf hydrodynamics, and
6. upwelling and food security.

NATIONAL IIOE WORKPLANS

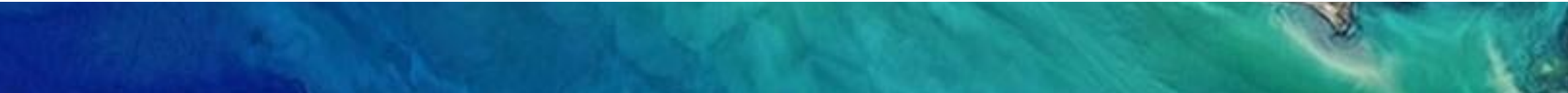
1. Kenya
2. Madagascar
3. Mauritius
4. Mozambique
5. South Africa
6. Tanzania

- ✓ Issues/phenomena/processes to study (national & regional)
- ✓ Sampling transects/stations (possible RV??)
- ✓ Parameters to be sampled (Essential Ocean Variables??)
- ✓ Frequency of surveys (and when?)
- ✓ Data processing, analysis, publications
- ✓ Possible participating institutions
- ✓ Capacities required/available (legacy institutions)
- ✓ preliminary work??



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REGIONAL SURVEYS-PROPOSALS



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Somali Upwelling and Penetration of Red Sea water

Information on environmental variability, upwelling, productivity and related fisheries. Determine how Red Sea water reaches the WIO to increase understanding of global thermohaline circulation & inter-ocean water exchange

Kenya and Tanzania Coasts

Mapping needed of inshore circulation patterns. Information needed on larval transport, recruitment, environmental conditions for fisheries, and pollutant dispersal

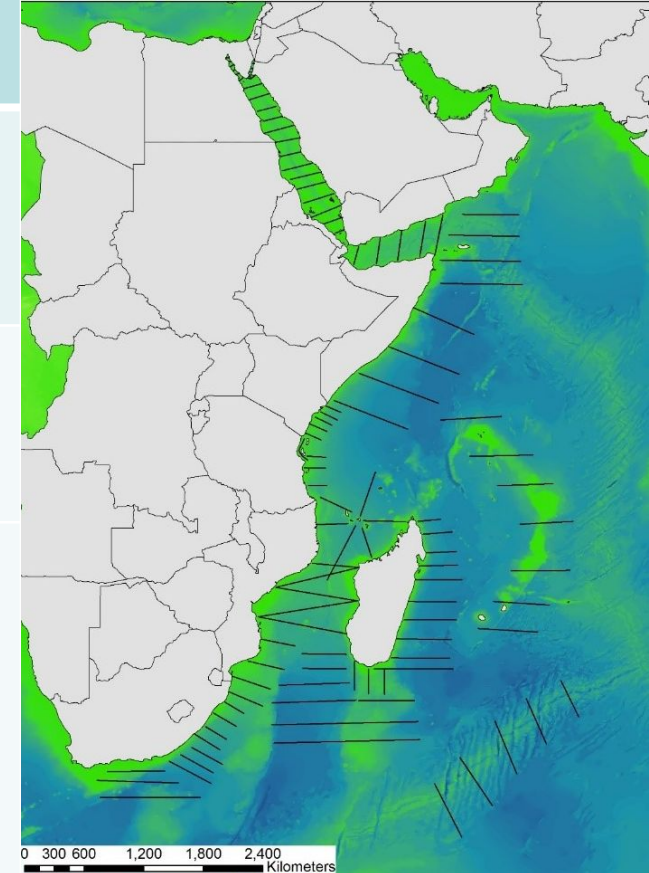
Mozambique Channel

Information needed on the shedding and triggering of Mozambique eddies. Information also needed on productivity

Areas of the Mozambique and SA coasts

Information needed on eddies to determine effects on overall ecology of the areas and particularly on downstream biodiversity, influence on shelf circulation, disposition of river outflows, dispersal of pollutants and thus habitat of organisms, and potential role on health of prawn fisheries

Understanding of the hydrodynamics of the Agulhas Bank to enhance existing information on the valuable anchovy and sardine fishery spawning ground which has implications for the health of these fisheries in the Benguela Current LME



REGIONAL SURVEYS - PROPOSALS



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Southwest Indian Ocean shelf regions

Knowledge of shelf circulation patterns and transport of fish larvae, dispersal of pollutants. Information on system productivity needed

Comoros Gyre

The Gyre is an anti-cyclonic eddy that is generally located from 10°S to 15°S and between the north-east coast of Mozambique and the north-west coast of Madagascar

Mascarene Plateau

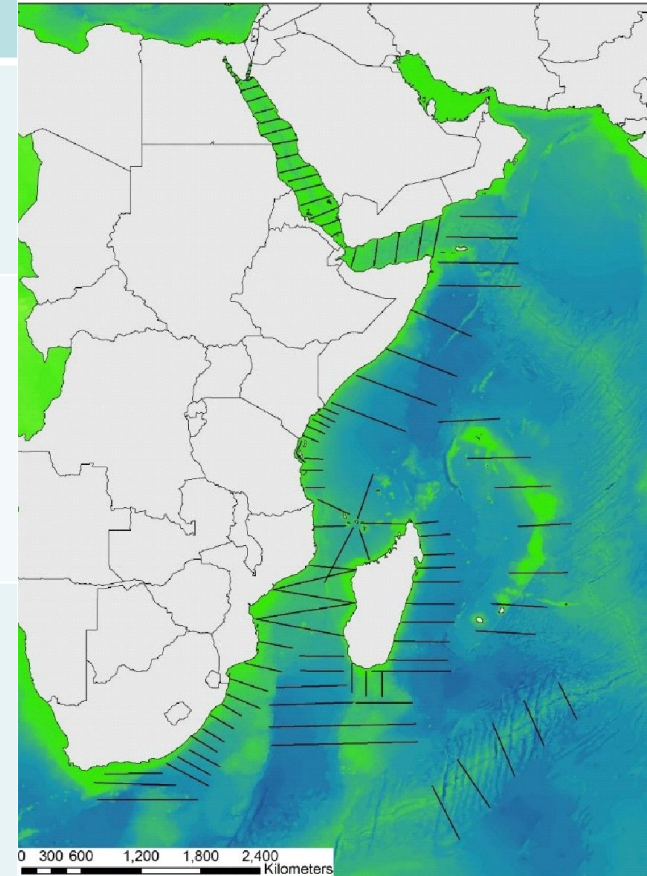
Information on the interaction of physico-chemical and biological processes in this large, shallow, mid-ocean region. Specific information needed on seagrass beds, overall climatic patterns, variability, and the potential influence of the Indian Equatorial Jet on productivity

Southern Madagascar

The splitting of the southern and northern branch of the East Madagascar Current: Knowledge of shelf and coastal circulations, biodiversity, chemistry and geology virtually non-existent.

The forcing of the South Madagascar upwelling cell: Baseline information on coastal circulations, biodiversity, chemistry and geology

Seamounts: Dynamics of the 6 seamounts at the edge of the SWIO ridge in terms of fisheries and biodiversity



IN SITU MEASUREMENTS



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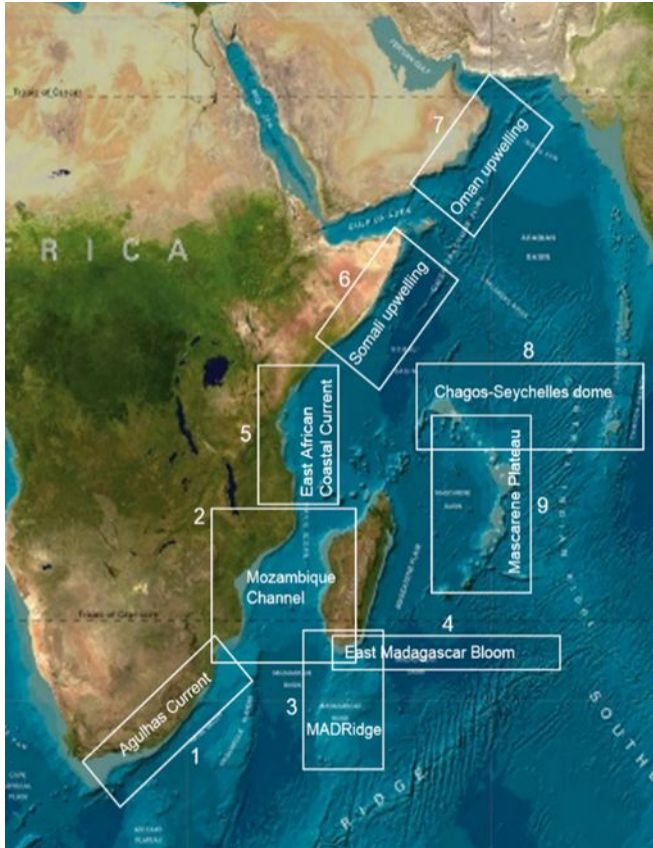
- ✓ Additional tidal stations with met ocean sensors
- ✓ Wind and waves measuring systems -possibly on light houses?
- ✓ Sea surface temperature measurements
- ✓ Network of moored stations

WESTERN INDIAN OCEAN UPWELLING INITIATIVE - WIOURI



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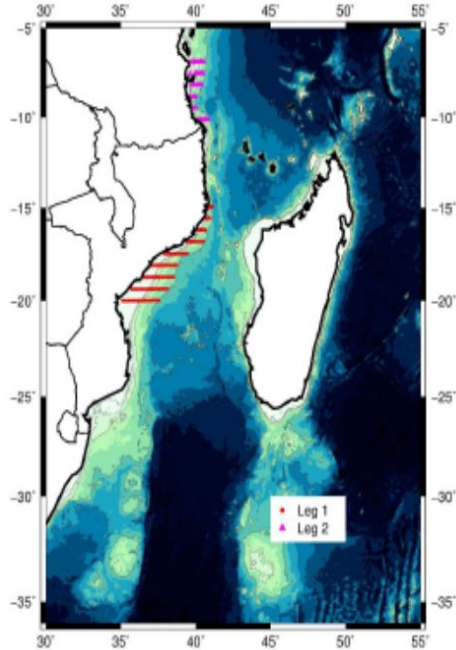
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9 WIO REGIONAL UPWELLING SYSTEMS.

1. Agulhas Current driven upwelling
2. Upwelling in the Mozambique Channel
3. Madagascar Ridge and seamounts upwelling
4. Southeast Madagascar shelf and SICC chlorophyll-a bloom
5. Upwelling in the East African Coastal Current (EACC) and influence of major islands (Mafia, Zanzibar, Pemba)
6. Upwelling Somalia Current system
7. Oman/Arabian Sea upwelling system
8. Chagos -Seychelles upwelling dome and Chagos Ridge, and
9. Mascarenes Plateau induced upwelling



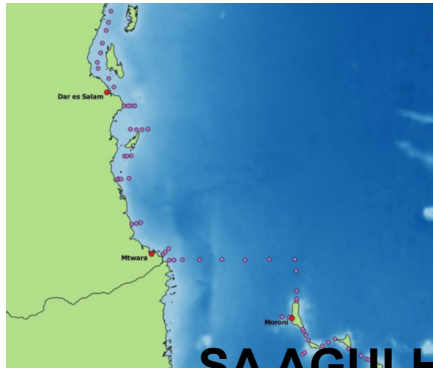


PERIOD: October – November 2017

SURVEY AREA: Off the coasts of South Africa, Mozambique and Tanzania.

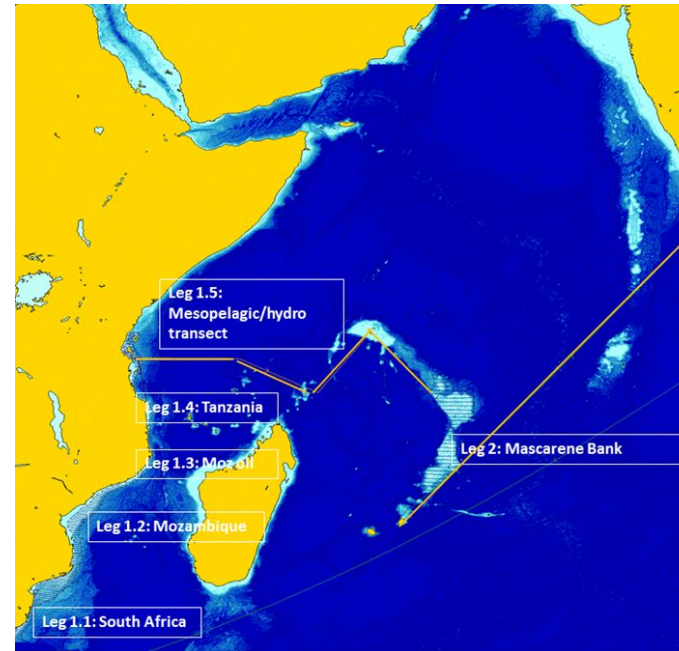
PERIOD: June–July 2018

SURVEY AREA: Off the coasts of South Africa, Tanzania and Comoros.



**SA AGULHAS II
SOUTH AFRICA**

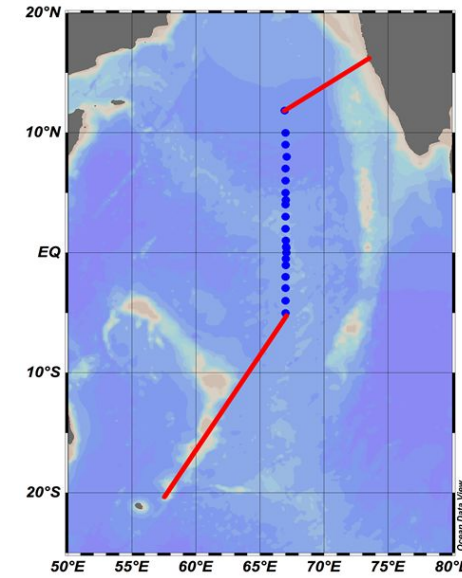
**RV MTAFIFI
KENYA**



PERIOD: January – June 2018

SURVEY AREA: South Western Indian Ocean

**RV DR FRODJHOF NANSEN
FAO/NORAD**



PERIOD: December 2015

SURVEY AREA: From Goa (India) to Port Louis (Mauritius). Focus on Longitude 73 degrees E.

RV SAGAR NIDHI - INDIA



SEA LEVEL MEASUREMENTS

GLOSS Stations

- **Djibouti:** Djibouti from 1995 replaced by a radar gauge 2007
- **Somalia:**
- **Kenya:** Lamu from 1996; Mombasa from 1986 (many gaps)
- **Tanzania:** Zanzibar, Mtwara
- **Mozambique:** Pemba and Inhambane (2005)
- **South Africa:** Durban, Port Elizabeth
- **Seychelles:** Pointe La Rue
- **Mauritius:** Port Louis (1986) upgraded in 2006 and Rodrigues
- **France:** Dzaoudzi 1985-1995 replaced in 1995 by radar tide gauge), Pointe des Galets (1979-1986)

Other stations

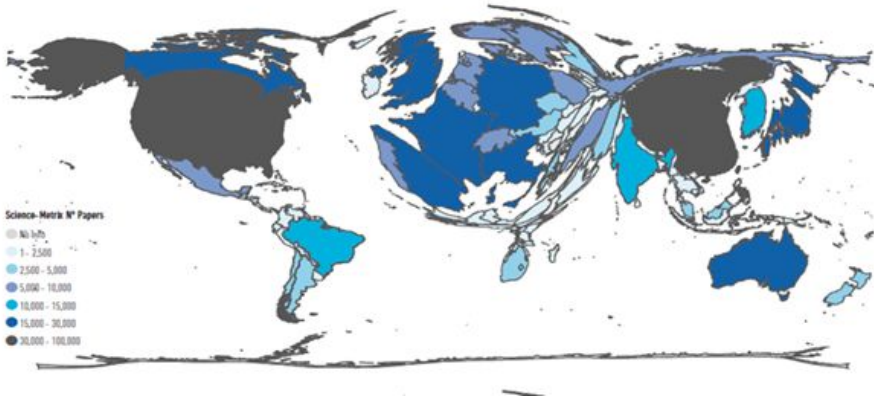
- **Kenya:** Kilifi, Shimoni and extra Lamu
- **Tanzania:** Dar es Salaam and historical data in Tanga
- **Seychelles:** historical data from Port Victoria and Praslin
- **Somalia:** short time series Mogadishu and Kismayo (1988)
- **Madagascar:** **Tamatave**, and historical data from Nosy Be, Tuléar and Fort Dauphin
- **Mauritius:** **Agalega**
- **South Africa:** Richards Bay, East London, Kynsna, Mossel Bay



CAPACITY DEVELOPMENT

Critical mass of experts in ocean observations and monitoring has not been achieved by most member states from the region.

Most of the member states in the region now have institutions offering training in marine sciences. However many of them are not well equipped for this purpose



Publications map: The area of each country is scaled & resized according to the number of ocean science publications - GOSR

Proposed IIOE-2 Centres of excellence:

- ✓ Operational Oceanography (**Nelson Mandela Metropolitan University, South Africa**),
- ✓ Marine Biodiversity (**Institute of Marine Sciences, Tanzania**),
- ✓ Ocean Data and Information Management (**Kenya Marine and Fisheries Research Institute, Kenya**) and
- ✓ Marine Remote Sensing (**Mauritius**).

- Sea level stations installed by ODINAFRICA, tsunami programme, and national institutions are the most wide spread equipment for ocean observations/monitoring
- Few member states from the region have ocean going research vessels, unmanned vehicles, or moorings. Most of the work done off small boats.
- SA Agulhas-II and the RV Dr Fridjhof Nansen have provided opportunities for surveys, training, as well as awareness and visibility for ocean observations. However these opportunities were not optimally exploited

- GOOS regional network needs to be re-activated and strengthened.
- Western Indian Ocean Marine Sciences Association (WIOMSA) and the Forum for Academic and Research Institutions provide useful mechanisms for collaboration in Eastern Africa
- The WIO-Early Career Scientists Network is also developing into a useful network for collaboration
- Marine science institutions in the region should also utilize existing science and technology networks in Africa (e.g. African Network of Scientific and Technological Institutions -ANSTI and the Conference of Vice-Chancellors, Deans of Science, Engineering and Technology - COVIDSET)

Ocean Decade Challenge 7. Ensure a sustainable **ocean observing system** that delivers timely data and information accessible to all users on the state of the ocean across all ocean basins.



Scope of the Challenges relevant to Africa	Identified issues and gaps
<ul style="list-style-type: none"> ✓ Ocean observations and monitoring ✓ Modelling and forecasting of ocean processes and ecosystems, including coupled ocean-atmosphere models ✓ Ocean data and information management ✓ Emerging technologies for ocean observations and monitoring 	<ul style="list-style-type: none"> ☐ Inadequate common platforms for data sharing; incompatible metadata formats; incompatible data (data existing in printed format/file type) ☐ Key shortcomings related to access to data (ownership e.g. lack of access to oil and gas industry data), data quality, lack of standardized observing parameters, and gaps in the types of data collected ☐ Gaps in sustained in situ observations for several Essential Ocean Variables (EOVs) ☐ Weak multidisciplinary approaches to observation, monitoring and modelling

- 6. Ocean observations and forecasting systems for Africa**
- Strengthen the Africa components of the ocean observations network as part of the overall development of the GOOS
 - Address specific needs to develop a network of ocean observation systems and regional forecasting models of ocean circulation, to provide baseline information on the oceanographic, biogeochemical and ecological state, changes and trends of the large marine ecosystems in Africa, and long-term coastal observations at key locations
 - Harmonized approaches to data standards, metadata and processing of big data
 - Work with industry and other stakeholders to optimize the collection of ocean observations by private or commercial vessels to feed into the observations system.



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