United Nations
Educational, Scientific and
Cultural Organization

Organisation
des Nations Unies
pour l'éducation
la science et la culture

Organización
de las Naciones Unidas
para la Educación
la Ciencia y la Cultura

Организация
Объединенных Наций по
вопросам образования
науки и культуры

Intergovernmental
Oceanographic
Commission

Commission
océanographique
intergouvernementale

Comisión
Oceanográfica
Intergubernamental

Межправительственная
океанографическая
комиссия

The International Indian Ocean Expedition

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IOC Sub Commission for Africa and the Adjacent Island States

INDIAN OCEAN – Facts and Figures

3rd largest ocean (after Pacific and Atlantic)

Extent from South Asia-Antarctica = 10,000km

Width at the equator = 6,400km

Surface area = 73,427,000 sq km

(20% of earth's surface)

Average depth = 3,400m

Greatest depth = 7,725 m

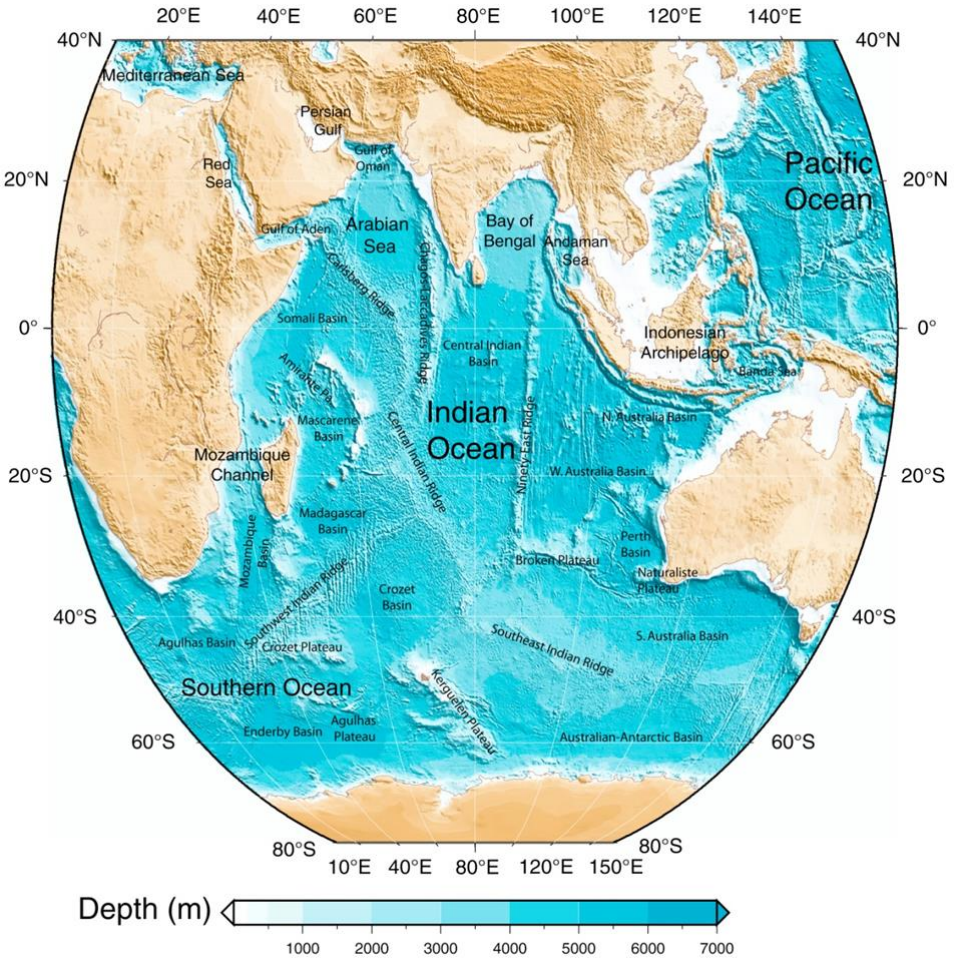
(Java Trench, S of Java, Indonesia).

General Background

Three unique features of the Indian Ocean:

- **The northern Indian Ocean has no subtropical or temperate zones.** As a result, high-latitude cooling of surface waters and subsequent ventilation of intermediate and deep water masses does not occur.

- **A second unusual feature of the Indian Ocean is the low latitude exchange between the Indian and the Pacific Oceans** via the Indonesian Throughflow (ITF).



- **The third striking feature of the Indian Ocean is the submarine topography**, which is dominated by three meridional ridges (the Mascarene Plateau, the Chagos-Laccadive Plateau and the Ninety East Ridge), and a triple junction where three spreading centers meet (the Southwest Indian Ridge, the Central Indian Ridge and the Southeast Indian Ridge).

International Indian Ocean Expedition.

Proposed by Scientific Committee on Oceanic Research (SCOR) established by the International Council of Scientific Unions in 1957:

- ✓ Indian Ocean potential for fishery resources, since most of the countries bordering the Indian ocean were deficient in proteins in their diets,
- ✓ Role of the northern Indian Ocean in effecting the monsoonal changes (vital for agriculture in the region, and also influence the current patterns, upwelling systems, productivity and the carbon dioxide cycle)
- ✓ Determine the limits to the use of oceans for waste dumping, including spent nuclear fuels.

IIOE IMPLEMENTATION PLAN

YEAR 1 and 2

- participating countries standardize equipment, and methods of data analysis and data logging so that results obtained by different ships would be comparable.

YEAR 2 and 3

- as many as 16 ships should simultaneously cruise in the Indian Ocean and make a combined ***assault on the largest unknown area*** of the earth – the deep waters of the Indian Ocean and its seabed.

SCOR Indian Ocean Working Group

Sub Committees

- Geology, Geophysics and Bathymetry
- Physical and Chemical Oceanography and Meteorology
- Marine Biology

Establishment of IOC - 1960

July 1960: Intergovernmental Conference on Ocean Research (UNESCO, Denmark)

Recommends establishment of Intergovernmental Oceanographic Commission to.

> *Promote **international cooperation and coordinate programmes** in research, services and capacity building, in order to learn more about the nature and resources of the ocean and coastal areas; and to **apply that knowledge for the improvement** of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States.*

IIOE Cruise line

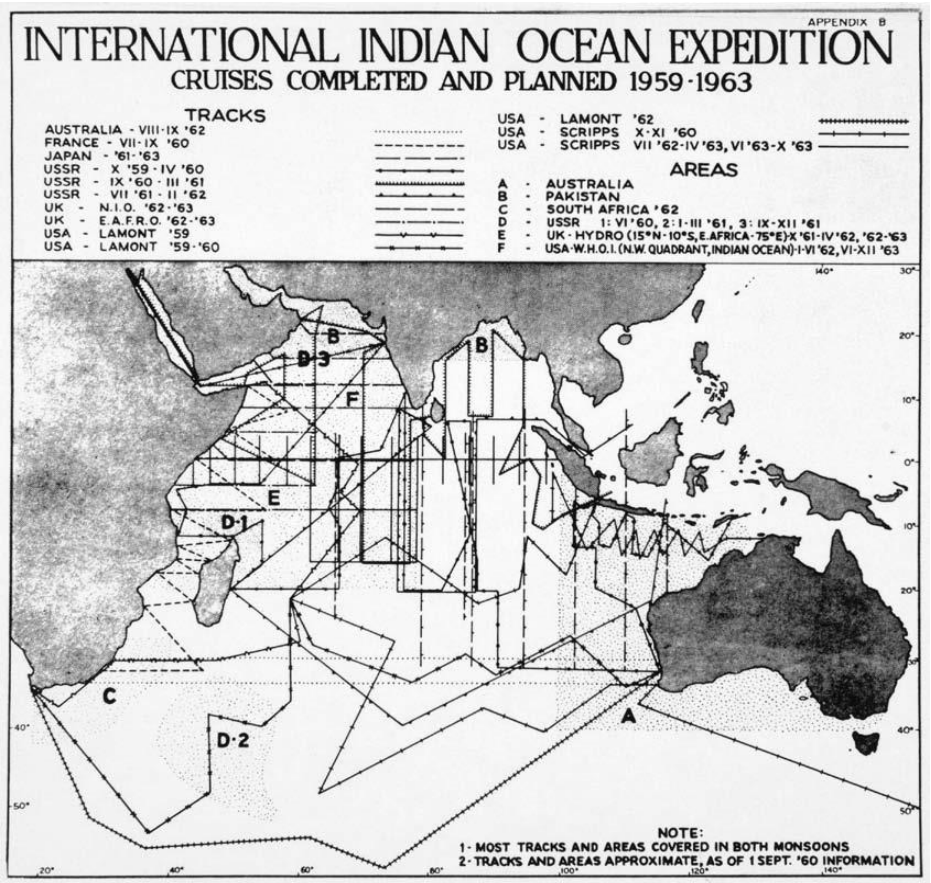


Diagram of cruises completed & planned 1959-1963 in the report by R.G. Snider available at the 1960 Copenhagen Meeting

- Duration of expedition: 1959 – 1965
- Coordination handed to IOC end 1962
- 40 research vessels from 13 countries, and researchers from 25 countries

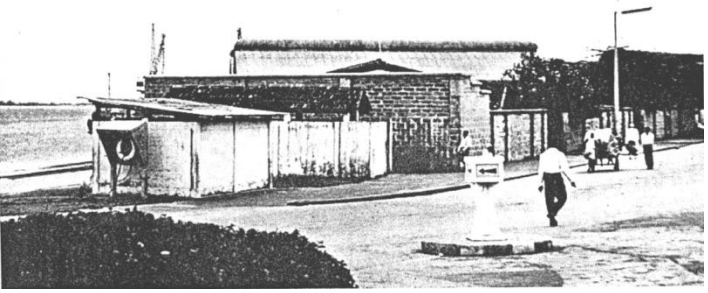
Achievements of the IIOE-ATLASES

- ✓ International Indian Ocean Expedition plankton atlas (10 volumes)
- ✓ Oceanographic atlas of the International Indian Ocean Expedition
- ✓ Meteorological Atlas of the International Indian Ocean Expedition
- ✓ Geological-geophysical atlas of the International Indian Ocean Expedition
- ✓ Phytoplankton atlas of the International Indian Ocean Expedition

Achievements of the IIOE

- ✓ PUBLICATIONS: Hundreds of papers, some included in 8 volumes collected reprints of the International Indian Ocean Expedition published by UNESCO.
- ✓ Establishment of NODCs and two WDCs (Washington and Moscow)
- ✓ Establishment of flora/fauna sorting centres: Cochin, Tunis and Washington DC (Smithsonian)
- ✓ Training of scientists from developing countries in RVs
- ✓ Strengthening/establishment of oceanographic research institutions: Karachi and Goa
- ✓ Improved vessels and instrumentation
- ✓ Standardization of equipment and methodologies

✓ Strengthening/establishment of oceanographic institutions - WIO



Above: EAMFRO, Zanzibar, & below, its successor, IMS.

- East African Marine Research Organization (EAMRFO), established in 1953 in Zanzibar, with sub-station later in Mombasa
- Marine Biological Station established at Inhaca, Mozambique in 1953
- Marine Research Station established by ORSTOM at Nosy-Be, Madagascar in 1962
- Station Marine de Tulear established in 1961 in Tulear, Madagascar established by the University of Marseilles

Photos: from (1) History of IMS by I. Brysceson, & (2) D. Masalu

Motivation for IIOE-2

- **Important scientific questions remain unanswered in the Indian Ocean.** These questions come from many fields within the Earth sciences, including geology, geophysics, atmospheric science, physical and chemical oceanography, biogeochemistry, ecology and fisheries.
- **Many new questions important to society have emerged since the IIOE:**
- **Population increase has contributed to growing negative impacts of multiple stressors on both coastal and open ocean environments.**
- **The human impacts of climate change, extreme events and monsoon variability are a growing concern, especially in low-lying areas**.

Sea level rise and flooding in Bangladesh

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Scientific Committee on Oceanic Research

Scientific Background and Motivation

Based on the science and societal drivers:

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

INTRODUCTION TO IIOE-2

Includes the overarching goal:

The overarching goal of IIOE-2 is to advance our understanding of interactions among geological, ocean and atmospheric processes that give rise to the complex physical dynamics of the Indian Ocean region, and to determine how those dynamics affect climate, extreme events, marine biogeochemical cycles, ecosystems and human populations.

This understanding is required to predict the impacts of climate change, eutrophication, acidification, and increased fish harvesting on Indian Ocean rim nations; and the interaction of the Indian Ocean with other components of the Earth System.

New understanding is also fundamental to policy makers for the development of management strategies for the Indian Ocean. Other goals of IIOE-2 include helping to build research capacity and motivating efforts to make oceanographic data from the region discoverable and widely accessible.

SCIENTIFIC THEMES

Theme 1: Human impacts

Theme 2: Boundary current dynamics, upwelling variability and ecosystem impacts

Theme 3: Monsoon variability and ecosystem response

Theme 4: Circulation, climate variability and change

Theme 5: Extreme events and their impacts on ecosystems and human populations

Theme 6: Unique geological, physical, biogeochemical and ecological features of the Indian Ocean

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SCIENTIFIC THEMES

Theme 1: Human impacts:

Core questions:

- How are human-induced ocean stressors (for example, warming, sea-level rise, deoxygenation, acidification, eutrophication, atmospheric and plastic pollution, coastal erosion and overfishing) impacting the biogeochemistry and ecology of the Indian Ocean?

- How, in turn, are these impacts affecting human populations?

SCIENTIFIC THEMES

Theme 2: Boundary current dynamics, upwelling variability and ecosystem impacts:

Core questions:

- How are marine biogeochemical cycles, ecosystem processes and fisheries in the Indian Ocean influenced by boundary currents, eddies and upwelling?
- How does the interaction between local and remote forcing influence these currents and upwelling variability in the Indian Ocean?
- How have these processes and (their influence on local weather and climate) changed in the past and how will they change in the future?

SCIENTIFIC THEMES

Theme 3: Monsoon variability and ecosystem response:

Core questions:

- What factors control present, past and future monsoon variability?
- How does this variability impact ocean physics, chemistry and biogeochemistry in the Indian Ocean?
- What is the effect on ecosystem response, fisheries and human populations?

SCIENTIFIC THEMES

Theme 4: Circulation, climate variability and change:

Core questions:

- How has the atmospheric and ocean circulation of the Indian Ocean changed in the past and how will it change in the future?
- How do these changes relate to topography and connectivity with the Pacific, Atlantic and Southern Oceans?
- What impact does this have on biological productivity and fisheries?

SCIENTIFIC THEMES

Theme 5: Extreme events and their impacts on ecosystems and human populations:

Core questions:

- How do extreme events in the Indian Ocean impact coastal and open ocean ecosystems?
- How will climate change impact the frequency and/or severity of extreme weather events, tropical cyclones and tsunamis in the Indian Ocean?
- What are the threats of extreme weather events, volcanic eruptions, tsunamis, combined with sea level rise, to human populations in low-lying coastal zones and small island nations of the Indian Ocean region?

SCIENTIFIC THEMES

Theme 6: Unique geological, physical, biogeochemical and ecological features of the Indian Ocean:

Core questions:

- What processes control the present, past, and future oxygen dynamics of the Indian Ocean and how do they impact biogeochemical cycles and ecosystem dynamics?

- How do the physical characteristics of the southern Indian Ocean gyre system influence the biogeochemistry and ecology of the Indian Ocean?

- How do the complex tectonic and geologic processes, and topography of the Indian Ocean influence circulation, mixing and chemistry and therefore also biogeochemical and ecological processes?

WIO PRIORITY TOPICS FOR IIOE-2

(i) Habitat mapping and living resource inventory

(ii) Connectivity and genetics

(iii) Air-sea interactions, climate variability and extreme events such as cyclones and storm surges

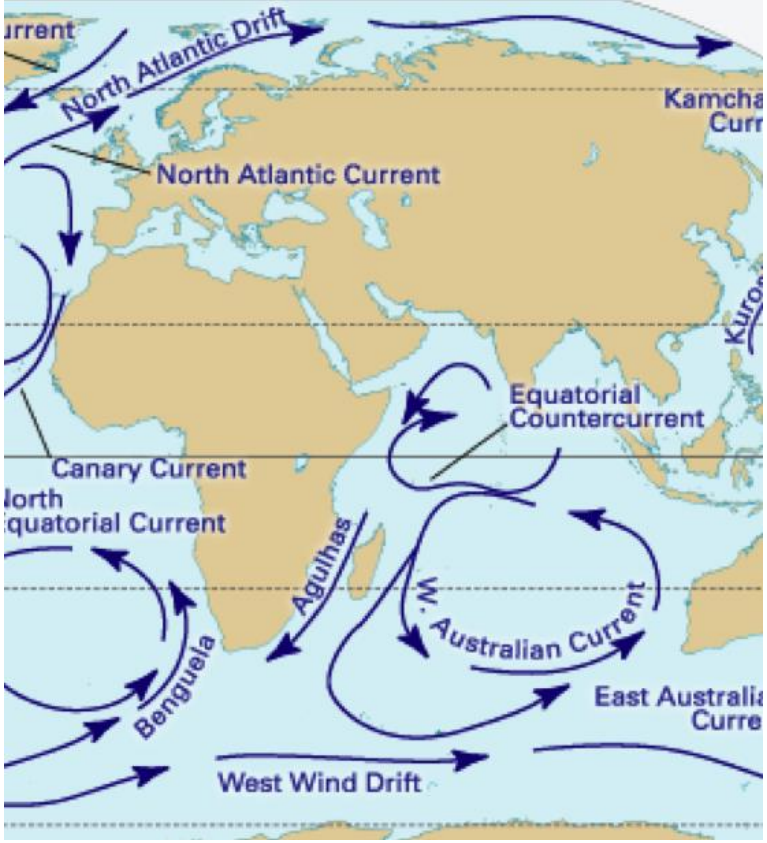
(iv) Geology – structural features of the WIO seabed

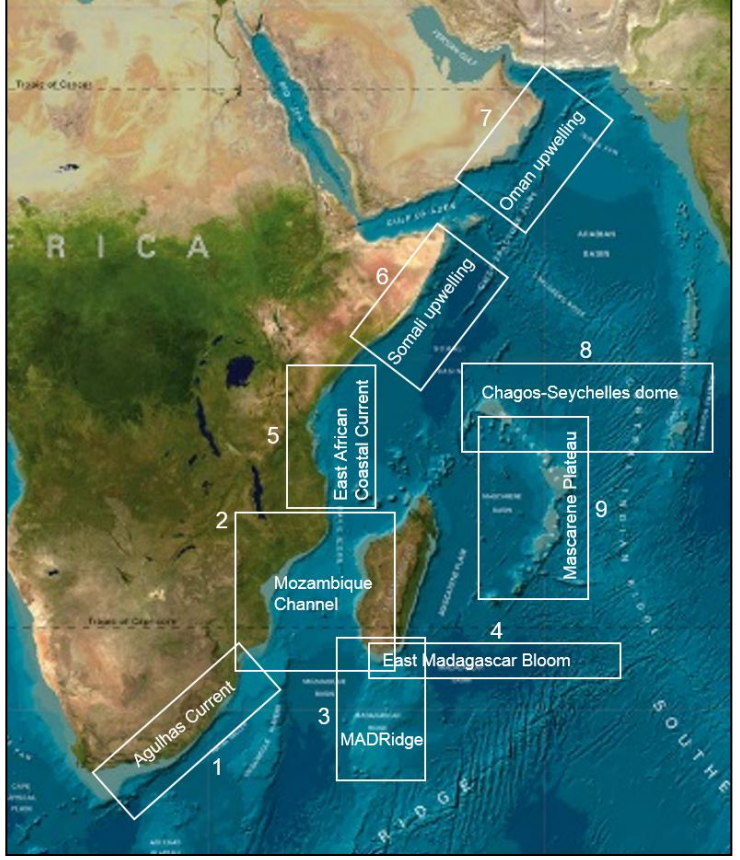
(v) Coastal and shelf dynamics

(vi) Upwelling and food security (WIOURI)

MAPUTO RECOMMENDATIONS
(OCTOBER 2015)

- ✓ Inventory of the past cruises undertaken in the WIO region
- ✓ Inventory of the data sets available in the WIO region
- ✓ Marine Science Country profiles updated
- ✓ Detailed National plans for the IIOE-2 (contribution of national and bilateral programmes to IIOE-2, coordination mechanisms at the national level, CD requirements, sharing of resources)
- ✓ Strengthen communication between the WIO region scientists
- ✓ Addressing emerging research issues such as: microplastics, marine biotechnology, pharmaceuticals from marine organisms (eg sponges and algae);
- ✓ Analysis, interpretation and publication of results
- ✓ Strengthening and re-branding existing institutions (legacy institutions)





- ✓ 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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One Ocean – One Planet

Thank you!

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