

CSIR-National Institute of Oceanography

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The National Institute of Oceanography (NIO) with its headquarters at Dona Paula, Goa, and regional centers at Kochi, Mumbai and Visakhapatnam, is one of the 37 constituent laboratories of the Council of Scientific & Industrial Research (CSIR), New Delhi. NIO was established on 1 January 1966 following the International Indian Ocean Expedition (IIOE) in early 1960s. The institute has grown today into a large oceanographic laboratory of international repute. The focus of research has been on observing and understanding the special oceanographic features that the North Indian basin offers. The inferences from this research have been reported in over 6500 research articles so far.

The institute has about 150 scientists (more than half of them with doctoral degree) and 190 technical support staff. The major research areas include the four traditional branches of oceanography-biological, chemical, geological/geophysical, and physical - and some other areas such as marine instrumentation and archaeology and has well equipped laboratories to conduct research in these and multidisciplinary areas. The institute also operates a coastal research vessel *CRV Sagar Sukti*, a 23 m vessel equipped for multidisciplinary oceanographic observations. The recently acquired 56.5 m long *RV Sindhu Sankalp* serves primarily on the continental margins, but it is capable of open-sea voyages. NIO's 80 m long research vessel *RV Sindhu Sadhana*, which will be capable of full open-sea studies, is under construction at the ABG Shipyard, Surat. It is expected to join the institute by end of 2012. NIO's scientists also have access to the ocean going research vessel *ORV Sagar Kanya*, operated by the Ministry of Earth Sciences. The institute has, over time, developed the capability of deploying and retrieving instruments hoisted over moorings in depths from 5 to 5,000 m. These instruments record time-series data during the period of deployment, which can be as long as two years. The institute has a library with 15,000 books and 20,000 back volumes of research journals, and online access to about 3500 current journals making it the best collection of printed literature on ocean sciences in the country.

In addition to basic research, the institute also carries out applied research sponsored by the industry. These studies include oceanographic data collection, environmental impact assessment, and modeling to predict environmental impact. The institute also provides consultancy on a number of issues including marine environmental protection and coastal zone regulations.

With the largest collection of ocean scientists in the country, and equipped with suitable ocean research infrastructure, NIO serves as an advanced center of education in ocean sciences. Many universities have recognized the institute for carrying out doctoral research, and a number of NIO scientists have been recognized as doctoral research guides. With the establishment of the Academy for Scientific and Innovative Research (AcSIR), CSIR's institutions are poised to take major initiatives in advanced education in the country. The institute has taken steps to start a School of Oceanography since 2011 to address the problem of shortage of advanced manpower in ocean sciences in the country. There are at present over 80 Junior/Senior Research Fellows (qualified through CSIR/UGC eligibility criterion) pursuing their doctoral studies in the institute. In addition, over 240 undergraduate and postgraduate students pursue their project research at this institute every year. About 5% of them come from foreign countries.

Some of the ongoing projects with a brief outline of their objectives are listed below.

Ocean Science Towards Forecasting Indian Marine Living Resource Potential

- i. To gain insights into working of a few important ecosystems on the continental shelf and slope off the coast of India through a combination of field observations, mesocosm experiments, and laboratory studies.
- ii. To improve our ability to simulate the physical systems.

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- iii. To develop tools for empirical prediction of the evolution of PFZs in open ocean.
- iv. To examine the potential impact of environmental changes on the inter-tidal and sub-tidal zones by conducting field observations and mesocosm experiments in these sensitive ecosystems.
- v. To conduct a inter-disciplinary observational and modeling study of a representative sample of the estuaries of India.

Geological Processes in the Indian Ocean: The Input Fluxes, Sinks and Paleoceanography

- i. Characterization of the sources of organic carbon in the sediments, estimation of the amount of (a) terrestrial organic carbon from peninsular Indian rivers reaching the sea (b) organic carbon stored in continental margins around India, and (c) carbon burial rates during the Holocene.
- ii. Quantification and geochemical fingerprinting of the amounts of mineral dust and anthropogenic aerosols reaching the northern Indian Ocean, their interactions and effect on ocean productivity, carbon cycle, rainwater chemistry.
- iii. Estimation of the fluvial trace and rare earth elemental fluxes from peninsular Indian rivers reaching the sea.
- iv. Estimation of the fluxes of volcanogenic and extra-terrestrial material in Central Indian and Wharton Basins and investigate the timing, causes, products and processes of volcanism and extra-terrestrial events.
- v. Quantitative estimation of various past climatic parameters (SST, surface salinity, carbonate ion concentration, and productivity), and reconstruction of paleo- monsoon intensity.
- vi. Understanding the relationship between monsoon and other regional coupled phenomena such as Indian Ocean Dipole (IOD), Indonesian throughflow (ITF), at glacial-interglacial, millennial and centennial time-scales.
- vii. Mapping the the cobalt rich Fe-Mn oxides on three seamounts in the Arabian Sea.
- viii. Mapping the zones of hydrothermal mineralization at the Central Indian Ridge.
- ix. Elemental and isotopic composition and the depositional environments of marine minerals and understand the metal accumulation processes in

relation to tectonics, climate and ocean processes.

- x. Understanding the active tectonics and the biogeochemistry of the associated ecosystems at the mid-ocean ridges, seamounts and fracture zones

Geo-scientific Investigations for Deciphering the Earth's Internal Processes and Exploration of Energy Resources

- i. Imaging the internal structures beneath the oceanic region, geologically complex basins and Indian continent. Modeling of crust and upper mantle structures for reconstruction of chronological evolution of the Indian continent and adjoining margins.
- ii. Determination of the nature and evolution of the crust beneath the Laxmi and Laccadive basins and 85°E Ridge. Identification of possible occurrence of hydrocarbons and gas hydrates in the overlying sediments.
- iii. Understanding geological processes contributing to the formation of gas hydrates; to map and evaluate the potential gas hydrate resources in Cauvery and Laccadive basins.

Indian Aquatic Ecosystems: Impact of Deoxygenation, Eutrophication and Acidification

- i. To understand processes responsible for formation of oxygen minimum zones in the North Indian Ocean and to evaluate the extent of ongoing changes in oxygen
- ii. Assess their distribution in the region through observations and modeling.
- iii. To establish trends in changes in seawater pH in the North Indian Ocean and evaluate the impact of acidification on biogeochemistry and ecosystems.
- iv. To understand the fate of fertilizers, especially nitrogen, in terrestrial ecosystems in order to evaluate their fluxes to the ocean and consequent modification of coastal biogeochemistry and ecology.
- v. To improve the understanding of OMZ processes such as redox transformations of biogenic elements and their interactions, microbial ecology, trophic transfers in low oxygen waters, and effect of oxygen deficiency on benthic processes, and to evaluate the current and future impacts of human activities on these processes.
- vi. To reconstruct paleo-redox conditions from sedimentary record from the Indian continental margin.

Analyses and Harnessing of Marine Biodiversity for Bioremediation of Aquaculture and Other Industrial Effluents

- i. Biodiversity and habitat analyses for biotechnologically useful marine biota possessing in particular bioremediation properties;
- ii. Screening for Bioactivity potency for pollutant degradation/detoxification, and biochemical characterizations of the most promising, select moieties;
- iii. Purification, characterization and screening of select bioactive molecules/principles useful pollution bioremediation;
- iv. Optimization of culture-conditions for microflora and standardization of protocols for preparing extracts;
- v. Sequential fractionation, Biochemical/structural characterization of novel principles -for instance- of an enzyme with the highest heavy metal-detoxifying potency, a set 2-3 best performing marine proteases, phosphatases, kinases and laccases;
- vi. Cyto-toxicity evaluation of economically viable marine biotic bioremediating principles and compound/s.

Impact of Natural and Anthropogenic Stresses on the Coastal Environment of India

- i. Studies on the physical, chemical and biological processes of the coastal waters as well as the impact of various natural and anthropogenic stresses on the coastal zone by optimizing the data collection and processing techniques, improving the modelling techniques and monitoring through multidisciplinary approach.
- ii. Studies on the wave energy dissipation due to suspended sediments and air-sea momentum flux during cyclone using WW3 / WAM and SWAN models.
- iii. Assessment of the Coupling of atmospheric (MM5/WRF) and ocean (ROMS) models to understand the influence of general circulation of the Indian Ocean and its role to coastal processes.
- iv. Establishment of observation systems for measurement and real time reporting of sea level and surface meteorological parameters.
- v. Monitoring and modeling the dynamics of surf zone, beach face and shoreline at select locations (Ratnagiri, Honnavar, Puduchery and Rameswaram).

- vi. Assessment of the vulnerability of the coasts to different sea-level rise scenarios (Eg: Kerala coast and the Gulf of Kachchh coast).
- vii. Studies on the formation and transportation of tar balls to the west coast of India.
- viii. Determination of waste assimilative capacity of Mumbai coastal waters using WASP water quality model.
- ix. Monitoring of the water and sediment quality and microbiology to assess the health of coastal waters as well as using biota as indicators of toxic metal contamination and index of pollution.
- x. Study on the pollution of the coastal, estuarine and riverine environments using WQI and TSI methods and modeling.
- xi. Assessment of sediment geochemistry of major and trace elements in the estuarine and coastal sediments, and studying the sediment pollution using satellite data.
- xii. Development of the advisories to coastal stakeholders using the expertise gained through measurements, modeling and monitoring of the coastal oceans,

Geological and Geophysical Studies of Coastal Zone of India

- i. High resolution geo-scientific investigations of coastal regions off west coast of India.
- ii. High resolution geological and geophysical exploration of seabed and sub-seabed features to address issues related to societal and industrial applications.
- iii. Coastal zone investigations related to delineate CRZ for Govt. and industrial agencies.
- iv. Creation of up to date geo-scientific database using Geographic Information System

Development of Autonomous Platform/s for Ocean Applications

- i. Study of bio-optical properties of the coastal waters
- ii. Understanding the role of bio-optical properties in the regions of oxygen minimum, thermal inversion layers, algal blooms, dust plumes and underwater visibility.
- iii. Development of various bio-optical algorithms of the coastal waters for the ocean color remote sensing applications.

- iv. Development of simple systems for automated measurements of multiple water parameters during blooms in the coastal waters and the estuaries.

Marine Ecological Assessment and Studies for Sustainable Developments in the Coastal and Shelf Areas in West Coast of India

- i. Marine environmental impact assessment of designated coastal developments with multidisciplinary approach and recommendation for suitable marine environment management plan to minimize adverse impacts on local ecology.
- ii. To continue periodic monitoring of water quality, sediment quality and biological diversity of the coastal and inshore areas of Gujarat and Maharashtra states under the COMAPS to identify changes, if any, beyond the natural variability.
- iii. To investigate the environmental and ecological recovery of Thane and Versova creeks in space and time subsequent to reduction in pollution loads and isolation of novel microorganisms with possible bioactive properties.
- iv. To develop expertise in the use of numerical models for quantitative prediction of selected impacts on marine environment due to designated activity in the coastal zone.

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Eco-biogeography and Biotechnology of Estuaries and Coastal Waters of India

- i. Study of different biogeochemical processes in Cochin estuary and adjoining coastal marine regions.
- ii. Studies on microbial ecology of Indian estuaries / coastal waters.
- iii. Marine microbial biotechnology – delivering useful products for the society.
- iv. Environment impact assessment studies - contribution to society and advisories to industry.

Coastal Processes and Tectonics of Eastern Continental Margin of India

- i. internal waves and their impact on the sound propagation from in situ observations and modeling Beach processes and their response to the coastal circulation variability
- ii. Upwelling variability along the central east coast of India
- iii. Phytoplankton physiology and major elemental cycling in the coastal waters.
- iv. To decipher the structure and tectonics of the offshore basins of ECMI from the marine geophysical studies.
- v. Variation of late Quaternary sea level and delineation of marine geohazard regions using shallow seismic data.

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