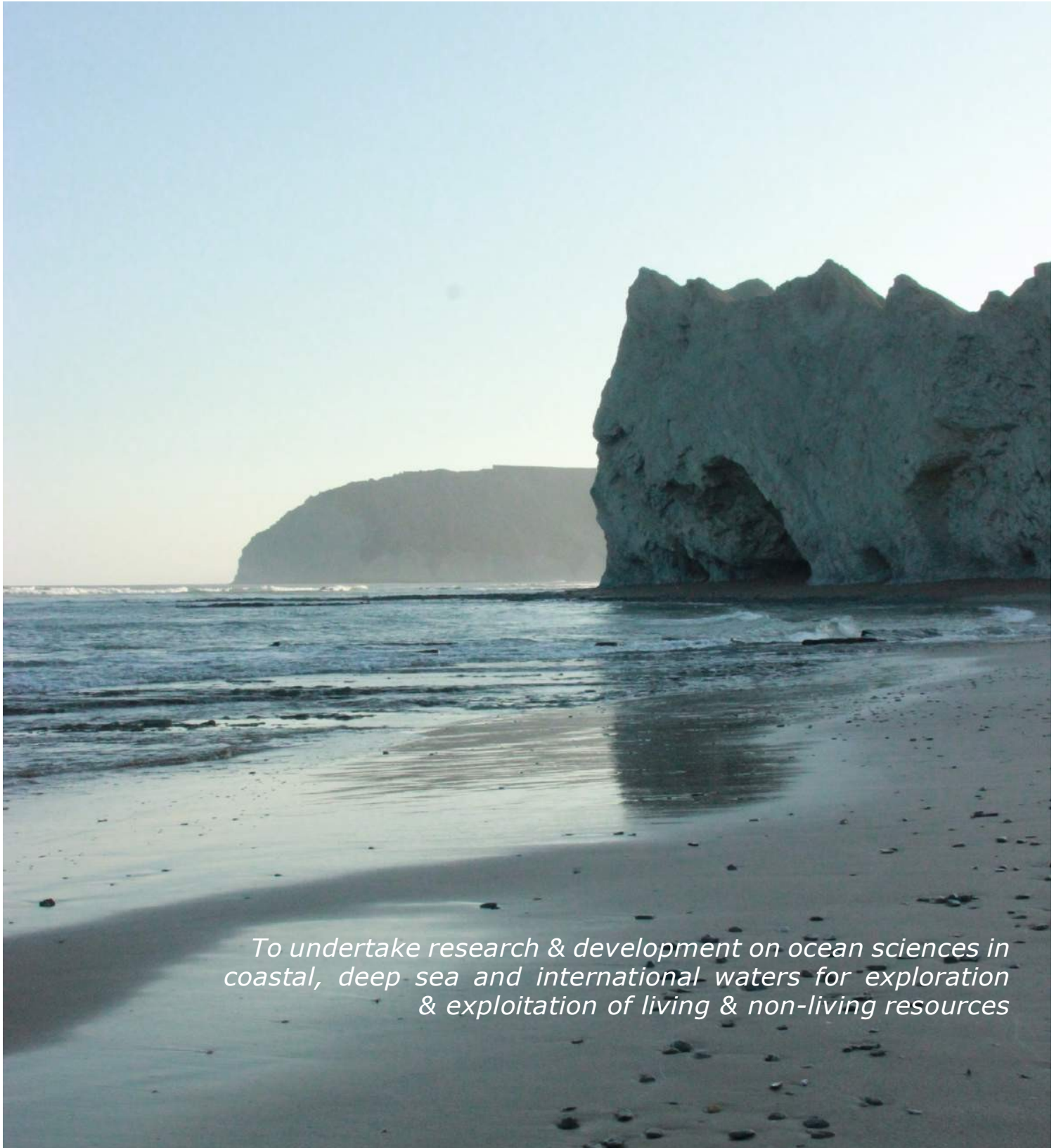




National Institute of Oceanography



To undertake research & development on ocean sciences in coastal, deep sea and international waters for exploration & exploitation of living & non-living resources



National Institute of Oceanography (NIO) was established in June 1981 as an autonomous body under the Ministry of Science and Technology (MOST), Government of Pakistan. Its major tasks are to undertake mission-oriented research and development programmes for the exploration, exploitation, utilization and management of ocean resources, provide guidelines to develop a viable national ocean policy and establishment of National Oceanographic Data Centre for protection/conservation of marine environment and ocean resources. The Institute's aims are to develop and strengthen the capabilities and facilities for achieving these objectives. NIO's work domain extends from the atmosphere to the ocean floor and below it, and from the coastal region to the great mass of the deep oceans.

Pakistan coast is about 1000 km long extending from Indian border in the east to the Iranian border in the west. The Exclusive Economic Zone (EEZ) of Pakistan is about 290,000 sq. Km. The total maritime zone of Pakistan is over 30% of the land area.

This region is characterized by distinctive oceanic phenomena i.e. monsoons, that influence rich fisheries, mineral, and hydrocarbon resources. The extensive survey, data collection and research are required to understand the above processes and features that drive the richness and distribution of the living and nonliving resources and their sustainable exploitation and conservation.

The National Institute of Oceanography is the focal institution for ocean research in the country. The main components involved in the development of NIO are:

- Development of professional and technical man power.
- Development of institutional capacity (field and laboratory).

- Management capability for marine data acquisition and processing.

The Institute strives to achieve these successfully. Since the establishment of NIO in 1981, the regular budget of NIO has increased manifold and efforts are being made to strengthen the R&D capability in the field of oceanography. Laboratories are being equipped with the state of the art instruments. NIO now has grown at international level for pursuing oceanographic research and surveys.

The headquarters building of NIO is located at Clifton, Karachi and NIO is also operating three oceanographic substations along Pakistan coast i.e. Mirpur Sakro, Sonmiani and Gwadar. The total core strength of NIO is 113 personnel which includes scientists and supporting staff, who are engaged under regular programme. There are also personnel who are engaged under its various projects.



NIO Head Office at Karachi

Research Capabilities

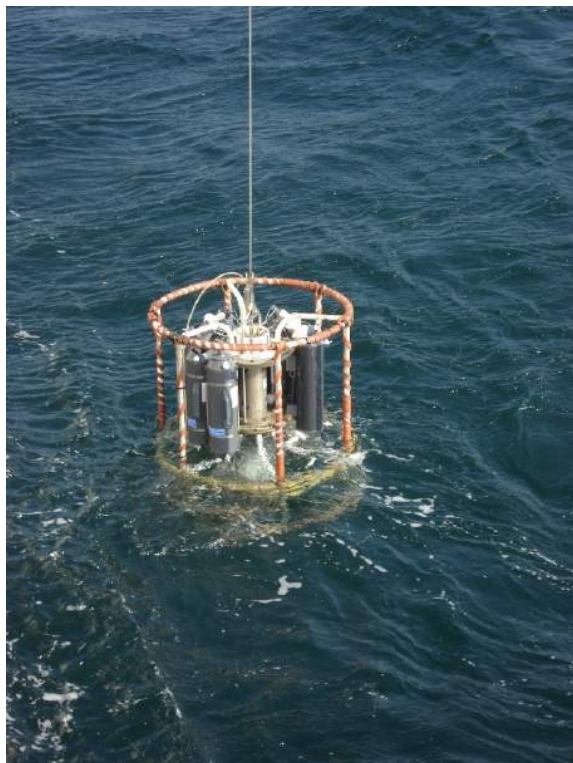
Physical Oceanography

The physical processes in the oceans relate to the study of waves, tides, currents and circulation; the influence of the weather and climate; and the transmission of light and sound in the oceans. The monsoons in the Arabian Sea have a profound influence on the oceanography of the region and they also play an important role in modulating the global climate

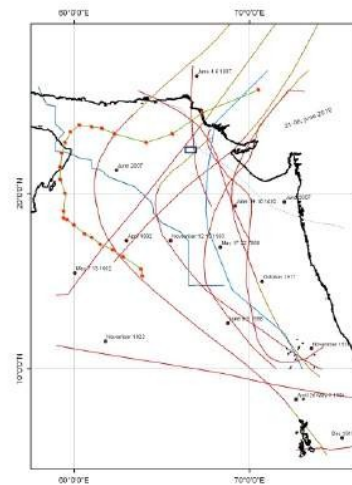
Physical oceanographers at NIO are involved in experimental, theoretical, laboratory and numerical investigations of oceanic motions that occur over a wide range of scales.

The major fields of research to understand the physical processes of deltaic, coastal and offshore waters of the northern Arabian Sea region are:

- Sea level changes and coastal water dynamics.
- Distribution and structure of oceanic fronts in the shelf seas.
- Analysis of oceanic and tidal currents
- Tidal predictions for ports along Pakistan Coast.
- Spatial and temporal variations in coastal processes.
- Numerical modelling.



CTD & Multi-water sampler in operation



Studying Extreme Climatic Events effecting Pakistan, Cyclones hitting Pakistan coast in the last 100 years.

Biological Oceanography

The Arabian Sea is one of the most biologically productive areas of the Indian ocean. The two unique features: the seasonal monsoonal cycle and the extensive and pronounced oxygen minimum zone (OMZ) of the Arabian Sea are particularly important in influencing the biological productivity of the region.

Biological oceanographers at NIO study the temporal and spatial distributions of populations of marine organisms and their interaction with each other and with their environment. The work is predominantly focused at the ecology, productivity at different trophic levels in order to provide basic information required to understand the marine living resource.

The emphasis is given to Fisheries Oceanography, Marine Ecology, inventory and evaluation of living resources, Food web dynamics and Aquaculture.

The main research areas are:

- Spatial and temporal changes in the distribution and breeding patterns of marine organisms in the coastal and deep waters of Pakistan.
- Primary productivity in the coastal waters.
- Food web dynamics and Mangrove ecosystem studies in the nearshore coastal environment.
- Ecological problems created due to industrial and recreational activities.
- Rearing techniques for the production of indigenous and priced species of shrimp and fishes for development of aquaculture.
- Inventory and evaluation of living resources.
- Bio-geographical Information Systems.
- Habitat mapping, Marine Protected Areas & Sites fo Special Ecological Interest.
- Flux studies and role in the biological cycles.



Bongo Net for Zooplankton sampling.



Scientists working in Biology Laboratory.

Chemical Oceanography

The central theme of chemical oceanographers at NIO is to describe and evaluate the ocean as a chemical system. The research at NIO has mainly addressed: Chemistry of Indus estuarine environment and its effect; pollutants from land based activities and their hazard potential for marine environment, distribution of nutrients and dissolved gases in the sea. The pollution monitoring is oriented to generate necessary data for the formulation of pollutant discharge standards and for adoption of pollution control measures.

- The focus of research is :
- Dynamics of chemical components in sea water, sediment and marine organism.
- Monitoring of heavy metal pollutants and chlorinated hydrocarbons in the inshore and coastal waters.
- Influence of industrial and municipal waste waters on the coastal and marine environment.
- Determination of assimilative capacities of the receiving waters development of water quality criteria for the coastal waters around the municipal and industrial waste discharge points.
- Environmental impact assessment for the coastal industry.



Chemical Oceanography- wet lab and sample preparation Laboratory

Technical capacity building

Coastal Pollution - A Serious Food Security and Health Risk, Under project activity estimation of Heavy metal contamination in the coastal Sediment and marine biota samples is in process of analysis by using Flame, Flame less and hydride generation Atomic Absorption Spectrophotometer (AAS) techniques established at NIO.



Scientists collecting water samples.



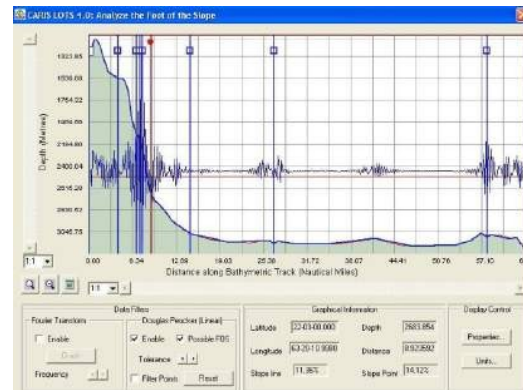
Atomic Absorption Spectrometer facility at NIO

Geological and Geophysical Oceanography

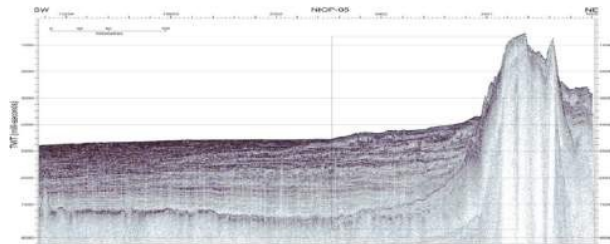
The offshore region of Pakistan is divided into two areas by the Murray Ridge. Northwest of the Murray Ridge is a triangular shaped zone in which the geology is dominated by the offshore extension of the Makran, a thrust belt bordering the southern parts of Iran and Pakistan. The larger portion of Pakistan's offshore area lies to the south and east of the Murray Ridge in the Arabian Sea where the dominant surface geology is that of the Indus Fan. The tectonic history underlying the geology of the whole area is a consequence of the collision of the Indian subcontinent with Eurasia.

The research in the Geological oceanography and Geophysics aims at producing geological maps of the ocean floor and the sub-floor at different scales. These maps show the lithology, stratigraphy and structures of the seafloor and the sub-seafloor in Pakistan's EEZ and provide the data base for evaluating non-living resources potential. Marine geologists at NIO study near-shore and shallower regions such as inner continental shelf and coast where ocean and atmosphere dynamically interact to produce complex and rapidly changing morphology.

Latest high speed workstations and dedicated software's, such as CARIS LOTS, CARIS GIS, SEISVISION, HYPACK, VISTA, ARC VIEW, FLEDRMAUS and QTC5 are in use at NIO. The Institute is equipped to process and interpret bathymetric as well as 2D multi-channel seismic data.



Foot of slope profile derived from CARIS LOTS.



Multi channel seismic line along Murray Ridge.

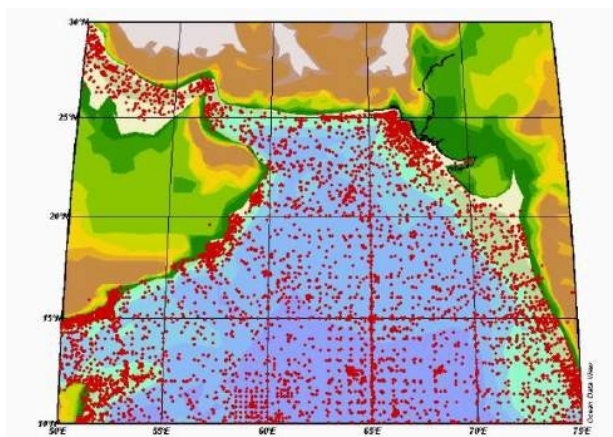


Geological Oceanography- geo physics laboratory

National Oceanographic Data

The NODC acts as a National repository for all types of oceanographic data pertaining to the territorial waters and EEZ of Pakistan. The NODC has basic computer facilities for storing and retrieving information. The main functions of the NODC are:

- Updating of data files for various oceanographic data
- Processing, categorization, and quality control of raw oceanographic data for adequate data management.
- Produce data products in the form of charts, maps and data filed on internationally prescribed formats.
- Develop computer programs for data processing for supplying processed data to the user's.



Data holdings at the NODC.

Pakistan's Continental Shelf Extension Programme

Under the United Nations Convention on the Law of the Sea (UNCLOS) the continental shelf is that part of the seabed over which a coastal state exercises sovereign rights with regard to the exploration and exploitation of natural resources including oil and gas deposits as well as other minerals and biological resources of the seabed. The legal continental shelf extends out to a distance of 200 nautical miles from its coast, or further if the shelf naturally extends beyond that limit.

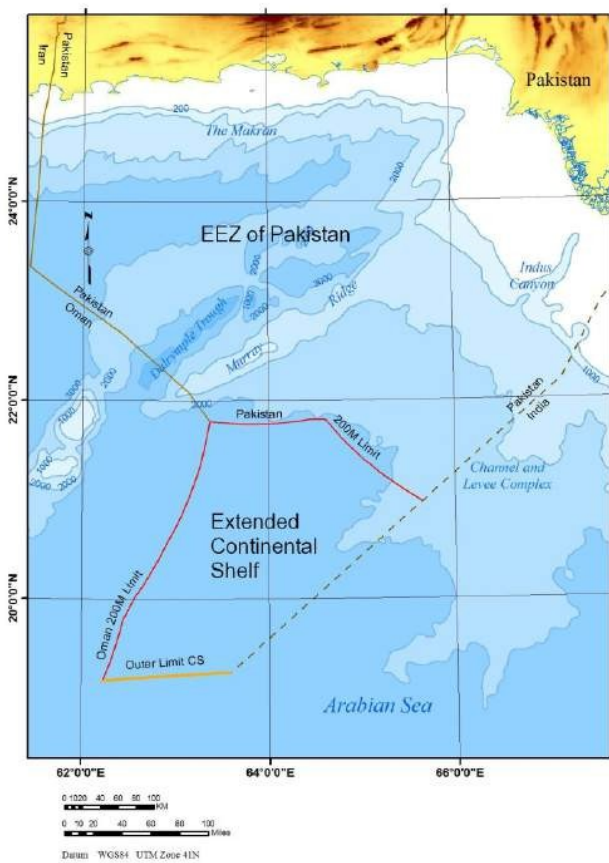
Where the continental shelf extends beyond 200 nautical miles a state is required by UNCLOS (Article 76) to make a submission to the Commission on the Limits of the Continental Shelf (CLCS).

Submissions for an extended Continental Shelf were required to be filed directly with the Commission on the Limits of the Continental Shelf (CLCS) with detailed marine geo-scientific data describing e. g. the shape of the continental margin, the location of the foot of the continental slope and the sediment thickness. Within the extended zone, a state has among other things the exclusive right of exploring and exploiting non-living-resources of the seabed and subsoil as well as sedentary species, whereas fishing rights remain limited to the EEZ.

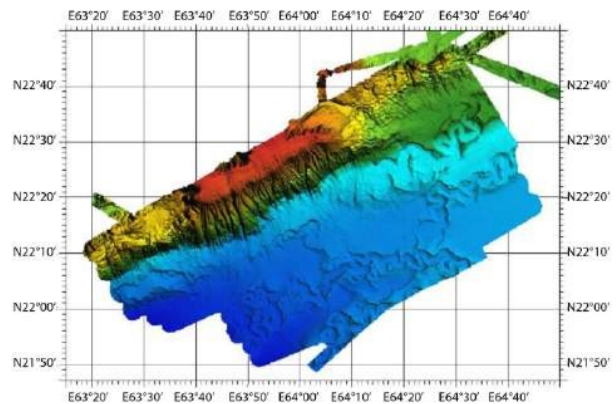
The Continental shelf project activities till submission underwent typical 3 phases: Desktop Study, Data Collection and Preparation of Submission. Scientists from National Institute of Oceanography and Hydrographers from Pakistan Navy Hydrographic Department worked dedicatedly in all phases.

After completing the entire requirements as per the Technical and Scientific Guidelines of the United Nations Commission on the Limits of the Continental Shelf the submission document along with all charts, maps and digital data was delivered by NIO to Pakistan's Permanent Mission to the United Nations in New York on 26th March 2009. Later, on the instruction of the Ministry of Science & Technology the Permanent Mission of Pakistan to the United Nation submitted Pakistan's Case for the extension.

On 10 March 2015, Pakistan delegation made a final presentation to the 21 member Commission on the Limits of the Continental Shelf. The presentation was greatly appreciated by the Commission. At the end of the 37th Session, the Commission on the Limits of the Continental Shelf formally adopted the Recommendation and accepted Pakistan's Case for the extension of its Continental Shelf from 200 nautical miles to the maximum 350 nautical miles. The total maritime area gained by Pakistan is more than 50,000 sq km.



NIO Scientists with consultants onboard during the seismic survey.



Bathymetry of offshore Pakistan.

NIO's Participation in the Fishery Resource Appraisal Program of Pakistan (FRAPP and Creek Survey Program (CSP))

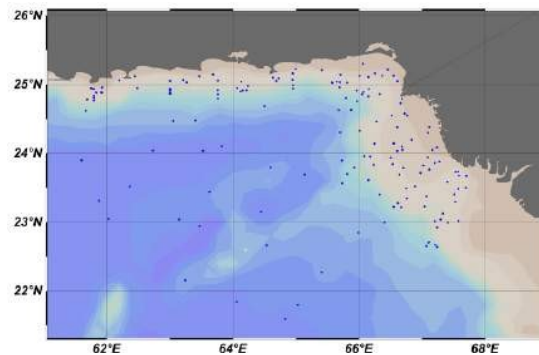
The National Institute of Oceanography (NIO) was invited by FAO/MFD to participate in this national activity by carrying out all the oceanographic activities. A Memorandum of Understanding (MoU) was signed between FAO/MFD and NIO for the execution of the project. In October-November 2009 the first fishery survey was carried out onboard the research vessel RV Ferdows-1. The second set of cruises (Leg 1&2) were carried out in October-November 2010 onboard the state of the art fishery/oceanographic research vessel RV Dr. Fridtjof Nansen. The final cruises were carried out in February 2015 onboard RV Ferdows. NIO oceanographers participated in all these cruises.

The oceanographic observations included in-situ observations, water quality (Salinity, Oxygen, Nutrients, Chlorophyll) and sample collections for Chlorophyll a and plankton (phyto and zoo) from the inshore and deep waters of the Pakistan Exclusive Economic Zone (EEZ). NIO has also contributed to the cruise reports and scientific findings have been presented at several national international conferences.

Some of the science questions that were addressed are:

- Variability of the deep O₂ minimum: physics or biology that regulates/ or is regulated by this feature ...?
- Chlorophyll a to predict the production zone and its connectivity with the fish potential- using ground observations and remote sensing
- Climatic and seasonal variability in zooplankton productivity over the last two decades (1992-2010), special emphasis to ichthyo-plankton and cephalopod paralarvae- connection to fishery production (holistic/specific view)
- Diversity maps for plankton- deep and coastal waters of Pakistan.
- Plug in the gaps in the data from the earlier oceanographic programs, repeat sampling at some of the historic stations.
- Update the national oceanography data bank.

NIO also participated in the creek survey program from 2013 - 2014. Observations and samples were collected from 12 major creeks of the River Indus delta.



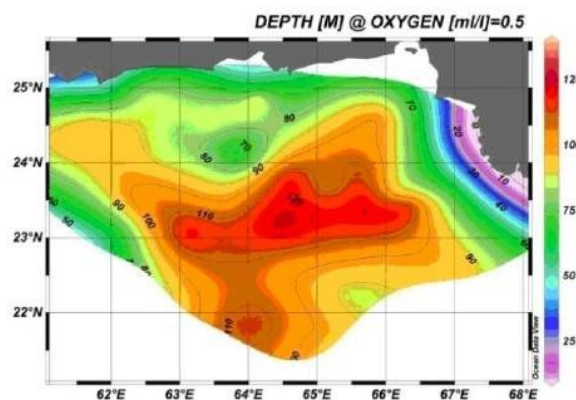
Stations of the FRAPP cruises



Nets being prepared for fish sampling



Plankton nets for sampling phytoplankton and micro-zooplankton during the November 2010 cruise.



Oxygen profile during the November 2010 cruise.

Hydrological studies off Karachi Coast.

The Government of Pakistan plans to extend the present capacity of the Karachi Nuclear Power Plant as a Karachi Nuclear Power Project under Pakistan Atomic Energy Commission (PAEC). In order to carry out the coastal Hydrological Studies for the area off Karachi National Institute of Oceanography (NIO) Pakistan was contacted by concerned authorities. Pakistan Atomic Energy Commission to provide assistance in studying the hydrological elements in the pre-agreed ocean area, and to know the scientific basis and basic profile to satisfy warm water discharge and low radioactive wastewater numerical modeling, physical modeling, and engineering design. The program was divided into phases:

Package-1 (in-situ Data Collection) Ocean Observation Station (one year continuously; synchronous observation at one location)

Engineering Ocean Area Hydrological Observations at 9 locations (half-month observation in summer and winter seasons but one month prior to the hottest and the coldest period)

Package-2 (Historical and present Data Analysis and Calculation)

Engineering Ocean Area Hydrological Analysis and Calculation

Package-3 (Development of Numerical Model)

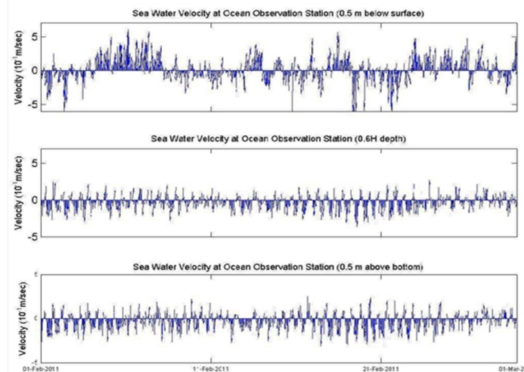
Seabed and Shore Stability & Numerical Modeling Calculation of Changes of Sand Erosion & Siltation in Water Intake & Discharge.

The Ocean Hydrological Observation Station was required to last at least 1 year for recording continuously; synchronous observation at the agreed observation point, and collect Whole Ocean hydrological observation profiles. The contents of Ocean Hydrological Observation Station included:

1. Tide level
2. Ocean current
3. Wind
4. Wave
5. Water temperature
6. Salinity
7. Sand concentration
8. Complete analysis of sea water quality (spring, summer, autumn, winter)



Acoustic Doppler Current Profiler (ADCP) being moored during survey.



RBR submersible data loggers.



Water quality sampling.

Bathymetric & Hydrographic Survey

In recent years NIO has carried out a number of national importance hydrographic surveys and has developed a sizable expertise for all oceanographic work including hydrographic survey. NIO's significant contributions include bathymetric survey of Pasni Fish harbour, Pishukan and Fish Landing jetties, Malir River and Karachi coast.

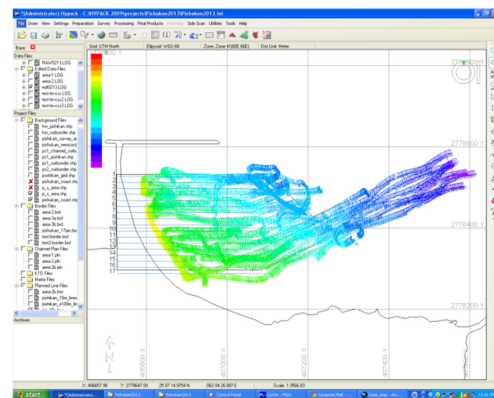
NIO provides pre and post bathymetric survey services and volume calculation to determine the volume of silt that need to be dredged according the jetty or port layout for the basin and channel area. Standard procedure of Bathymetric and topographic surveys according to Hydrographic manual of National Oceanic and Atmospheric Administration (NOAA), USA are adopted.

State-of-art software and equipment are used for the survey and post processing of data that include:

- HYPACK Survey Software
- The Bathy-500MF Survey Echo Sounder
- DGPS system FUGRO's SeaStar 310LRS
- Surfer
- ArcGIS



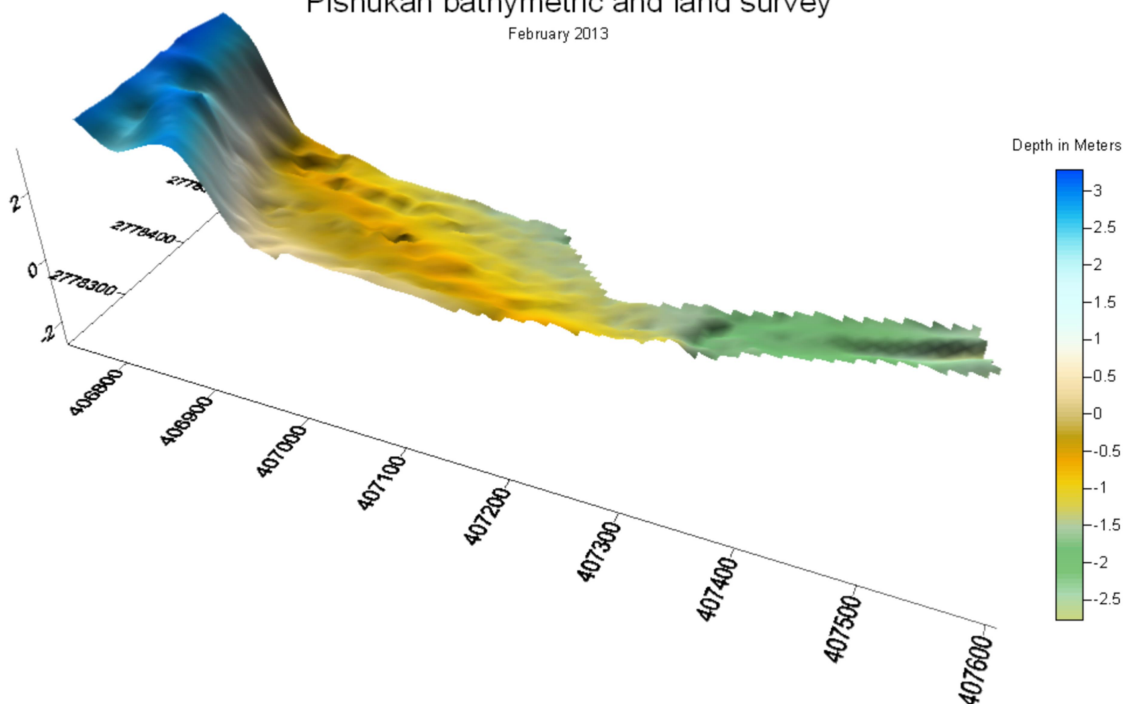
Bathy 500 Echosounder being used in bathymetric survey.



HYPACK Survey software output of bathymetric survey.

Pishukan bathymetric and land survey

February 2013



Ecological Study- Churna Island

The Government of Pakistan (GoP) has plans to develop 6600 MW Power Park at Gadani, Balochistan which will house 10 660 MW Power Plants to be setup by private investors as Independent Power Plants (IPPs). The National Institute of Oceanography was approached to carry out a set of surveys at the site, Marine Ecology Study on the proposed area was one of them. The Churna Island and Kaio Island Complex was included in the survey.



Geo-referenced Churna Island survey



Churna Island ecological survey - sub-tidal photographs.

Gadani beach with In the context of the Pakistan coast

The Gadani beach comprises of sandy substrates, with gravel, pebbles and large rocky area. The ecology is fairly diverse and the offshore comprises of Churna Island and Kaio Island Complex that are proposed MPA of Pakistan.

The Churna Island and Kai Island ("Choota Churna"). Churna Island is about 8-7 km offshore and where the average depth on the open sea side is approximately 16-17 m. The inner side upto 3-4 m and has coral formations (hard and soft coral) around this area that has grown since 2004 and the beginning of a young reef (personal communication). However, this has never been scientifically and systematically surveyed. But the area is a well-known recreational dive and fishing location. At the 10 m depth contour is the Kaio Island Complex "Choota Churna", and the ecology there is said to be quite diverse from the Churna Island.

The island is triangular and the dimensions are 1.5 x 1.5 x 0.8 kilometers. A geo-referenced dive survey (Manta Tow and Transect-Quadrat method (Hill and Wlkinson, 2004), covering the entire area around the Churna Island The survey will form a detailed baseline of the coral, surrounding ecosystem. The diver swam around the island with a video camera to record the coral cover and the ecology around the entire island. The photographs were geo-tagged in GoogleEarth to obtain geo-referenced observations. The Line and Quadrat method survey, GIS tools were used to estimate the coral cover around the Churna Island.



Gadani beach survey using quadrat method.



Biota washing on to the Gadani beach.

Aquaculture Facility at NIO

Fisheries Sector has immense potential of contributing towards economic growth and development through marine aquaculture however, there is no established tradition of aquaculture in Pakistan. Crustacean culture particularly shrimp culture is practically non-existent. However, crustacean culture has enormous potential to emerge as a rapidly growing new industry in marine sector. The high prices of shrimp in local and international market and their significance as an export item has generated considerable interest among entrepreneurs (private sector). National Institute of Oceanography (NIO) has conducted considerable research regarding aquaculture particularly shrimp hatchery over the last couple of years and has established Pilot Shrimp Hatchery at Sonmiani and Shrimp Farms along Sindh and Balochistan coast.

NIO has successfully developed this technology which would be beneficial for shrimp farming sector due to availability of seed stock (Post Larvae) of shrimps at Pilot Shrimp Hatchery of NIO. The availability of seeds would enable the farmers to harvest two crops annually. The farmers involved in shrimp culture may produce about 1-2 tons of shrimps per hectare pond. Pakistan has a coastline of about 1000 km, out of which major areas along the coast are suitable for shrimp farming.

Benefits

The development of shrimp culture in Pakistan will enhance the export of fishery products particularly shrimp export to foreign countries. The demand of shrimp in the international market world over is very high therefore shrimp culture will prove very profitable business and the investors would be able to earn foreign exchange with only one time investment.

Facilities available at NIO shrimp hatchery

NIO has the complete infrastructure for shrimp farming i.e Pilot Shrimp Hatchery at Sonmiani with wet Lab., Algal Culture Lab., complete water purification system, Larval rearing tanks, Artemia culture tanks, facilities for mass culture/ feed for larvae, large fiber glass tanks for storing post larvae & setup for preparing artificial feed for juvenile & post larvae.



Shrimp feed prepared at NIO.



Microalgae mass culture.



Pumping station at Ghorabari



Harvesting shrimp from the NIO farm.



Shrimp from the NIO farm.

Brief Scope of NIO Services



COASTAL HYDRAULIC & SEABED SURVEY

Oceanographic Surveys, Seabed Bathymetric Surveys, Coastal Surveys, Coastal Erosion, Coastal Protection, Site selection for Ports, Jetties, Harbours, Power Plants and Desalination Plants.

OCEANOGRAPHIC SURVEY

Currents, Waves, Tides and Meteorological observations. Tidal level measurements and Prediction, Numerical Modeling, Bio-Resource Mapping.

ENVIRONMENTAL SURVEY

Environmental Impact Assessment, Contingency Planning, Natural Resource Damage Assessment, Remediation plans. Marine Mammal Observers

SHRIMP HATCHERY AND FARMING

Expertise in Shrimp Farming, Algal Culture Lab, Artemia Culture Facilities, feed for larvae, consultancy & training.

OCEANOGRAPHIC DATA SERVICES

Oceanographic Data Services for Pakistan's maritime areas

MARINE EXPLORATION & GEO-ENGINEERING SURVEY

Site surveys for offshore structures, Harbours, Jetties, Navigational Buoys etc. Submarine cable and pipeline route surveys, Mineral exploration in the coastal water, Geo-Resource Mapping.

MARINE POLLUTION SURVEY

Water Quality Monitoring and Assessment, Dilution and Dispersion of pollutants, Thermal Plume Study.

FEASIBILITY STUDIES

Coastal Surveys for site selection, Shrimp Farming, Power & Desalination Plants, Underwater Search and Surveys, Ports & Harbours.

TRAINING OFFERED

General Oceanography and Marine Instrumentation, Ocean Dynamics and Coastal Hydraulics. Law of the Sea, Marine Seismic Data Management. Marine Aquaculture Techniques. Laboratory and large scale Phytoplankton Culture etc.

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