National Institute of Ocean Technology

(Ministry of Earth Sciences, Govt. of India)

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
NIOT
CHENNAI

ANNUAL REPORT 2022-23

LTTD plant at Amini and Kadamat generated fresh water in July 2022, and February 2023 respectively. Finishing works are in progress at Kadamat Island. Works in Androth, Chetlat and Kiltan Islands of UT Lakshadweep is in progress. Kalpeni and Amini LTTD plants were inaugurated by Hon'ble President of India Smt. Droupadi Murmu on 18th March 2023 in presence of Hon'ble Administrator, UTL, Shri. Praful Patel, Senior officials and People of Lakshadweep, and, Officials of MoES-NIOT.

On August 12, 2022, Dr.Jitendra Singh, Hon'ble Minister of State (Independent Charge) of the Ministry of Earth Sciences and Ministry of Science & Technology, visited Sagar Anveshika at Chennai Port and hoisted Tricolour onboard Ship as part of 'Har Ghar Tiranga, Har Jahaj Tiranga'. He also met the senior scientists of NIOT onboard the vessel and reviewed the progress of the implementation of the Deep Ocean Mission program.

Union Minister Dr. Jitendra Singh launched India's first saline water lantern which was developed in-house. It works by the principle of ionization. The saline water lantern predominantly is meant to be used as a lamp, however it can also have a mobile charging device, which will make it useful in disaster prone areas for communication. The technology has been transferred to a few industries.

His Excellency Mr. Michael William Lodge, Secretary General, International Seabed Authority (ISA), accompanied by the following delegates from the ISA visited NIOT on 09 Feb 2023. His Excellency had a detailed discussion with the technical team working on deep sea mining project and also addressed the NIOT on ISA specific to Environmental Impact Assessment due to mining.

PREAMBLE

The National Institute of Ocean Technology (NIOT) was established in November 1993 as an autonomous society under the Ministry of Earth Sciences (MoES), Government of India. NIOT is managed by a Governing Body headed by the Secretary, MoES and the Director is the head of the Institute. NIOT is a scientific research institute in the field of Ocean Technology which functions under the aegis of Ministry of Earth Sciences (MoES), Government of India.

NIOT Chennai is located in a 50-acre campus in Pallikaranai, Chennai Tamilnadu and at Atal Center for Ocean Science and Technology for Islands (ACOSTI) Port Blair, Andamans.

The NIOT campus in Chennai has several research facilities, laboratories, integration bays. The integration bays are used for assembly and integration of large-scale deep ocean testing equipment and various machineries like underwater mining machine, ocean observation buoys, Unmanned Underwater Vehicles etc. There are several laboratories like Acoustic Test Facility, Hyperbaric test facility, water quality, and marine biotechnology laboratories for in-house testing of underwater components and samples. A unique test facility which is used to carry out the research activities in the areas of Low Temperature Thermal Desalination and Ocean Thermal Energy Conversion is operational at NIOT.

Mandate of NIOT

The Major objective of NIOT is to develop reliable indigenous technologies to solve various challenges associated with harvesting of living and non-living resources in the Indian Exclusive Economic Zone (EEZ), which is about two-thirds of the geographical area of India.

Mission Statement of NIOT

- To develop world class technologies and help with their application for sustainable utilization of ocean resources.
- To provide competitive, value added technical services and solutions for organizations working in oceans.
- To develop the knowledge base and institutional capability in India for management of ocean resources and environment.

MEMBERS OF THE GOVERNING BODY OF NIOT

1	Secretary, Ministry of Earth Sciences (MoES), Govt. of India	Ex-Officio	Chairperson
2	Joint Secretary, MoES	Ex-Officio	Member
3	Financial Adviser, MoES	Ex-Officio	Member
4	Chairman RAC-NIOT	Ex-Officio	Member
5	Scientist G/H, MoES working as Program Head, NIOT	Ex-Officio	Member
6	Principal Secretary in-charge of the Department handling MoES or concerned Scientific Ministry, Govt. of Tamil Nadu	Ex-Officio	Member
7	Director, NIOT, Chennai	Ex-Officio	Member
8	Senior-most Scientist, NIOT	Ex-Officio	Member
9	Representative of NITI Aayog looking after the work of MoES	Ex-Officio	Member
10	Dr (Prof.) S. Anantha Ramakrishna Director, CSIR-CSIO, Chandigarh	Expert	Member
11	Dr. Y. Sreenivasa Rao, Director, NSTL, Vizag	Expert	Member
12	Prof. S.C. Misra, Director (Retd.), IMU, Visakhapatnam & Prof (Retd.) IIT Kharagpur	Expert	Member
13	Head / In-charge of Administration, NIOT, Chennai	Ex-Officio	Member Secretary

FROM THE DIRECTOR'S DESK

It is with great pleasure that I present the Annual Report of NIOT for the year 2022-23.

Our mandate is to design, develop and demonstrate technologies for sustainable exploration and utilization of living and non-living resources. This 3D mandate is implemented through two schemes of Ministry of Earth Sciences i.e. Ocean Services, Modelling, Application, Resources and Technology (O-SMART) and Deep Ocean Mission (DOM). The O-SMART comprises several areas of ocean technology such as Ocean Energy and Fresh Water, Coastal and Environmental Engineering, Ocean Acoustic, Ocean Electronics, Marine Sensor Systems, Ocean Observation Systems, Marine Biotechnology, and Vessel Management Cell.

Using NIOT's innovative technology of Low Temperature Thermal Desalination (LTTD), plants producing 1.5 Lakh litres per day capacity were commissioned in the islands of Amini and Kadamat in UT Lakshadweep. Hon'ble President of India Smt. Droupadi Murmu, inaugurated the Kalpeni and Amini LTTD plants on 18th March 2023.

As part OTEC (Ocean Thermal Energy Conversion) powered desalination plant in Lakshadweep, orders were placed for "Supply and Commissioning of plant equipment", "Supply and welding of HDPE pipe", and "Civil works" and work commenced at project site. Supply of HDPE pipes to the project site is complete. A surface buoy with a deep water mooring anchored at 1200m was deployed near Kavaratti Island to collect the current and temperature values at various water depths at the location. The buoy gives hourly data to the GPS. With an intent to provide service to society, a saline water lantern predominantly meant to be used as a lamp was developed in-house. It can also have a mobile charging device, which will make it useful in disaster prone areas for communication.

For implementation and sustainable coastal protection measures, Stakeholder workshops were conducted at Chennai and Thiruvananthapuram with wide participation from various Tamilnadu and Kerala State government department officials regarding requirements for sustainable inlets opening under the Indian Coastal Inlets Restoration Program (ICIRP). NIOT has been providing technical advisory services to Water Resources Department, Government of Tamil Nadu for the creek opening measures. A Memorandum of Understanding (MoU) was signed between Secretary, Department of Water Resources, Government of Odisha and Director, NIOT for "Providing Technical Guidance and Design & Drawing of Climate Resilient Coastal Protection Measures for the State of Odisha". Under the aegis of this MoU two projects have been taken up by NIOT for coastal protection.

NIOT's contribution to marine / ocean electronics and ocean acoustics has shown significant progress. NIOT is actively involved in Auto feeder development for open sea fish cage culture system for which field demonstrations shall be carried out. A bio-mass estimation system using Machine Learning algorithm is developed and trial production of 4 units are in progress. A small category heavy lift type Drone for marine applications has been customized.

A Digital Signal Processing (DSP) based prototype Acoustic Telephone Unit has been realized and successfully demonstrated for two-way voice communication in the Acoustic Test Facility (ATF). A Networkable Digital Hydrophone Array has been realized and demonstrated in the Acoustic Test Facility (ATF) for which patent has been granted.

It is my pleasure to state that NIOT is very active in the field of ocean acoustics research. Scientific Officers from the Ocean Acoustic Team were deputed to Longyearbyen, Arctic to carry out data retrieval from the deployed acoustic recorders incorporated with Coordinated Arctic Acoustic Thermometry Experiment (CAATEX) mooring. A newly developed Ambient Noise Measurement System (ANMS) with a pair of hydrophones incorporated with the OMNI mooring in Bay of Bengal was retrieved comprising of 5 months of noise records. The Shallow Water Acoustic Vector Sensor Array AutoNomous System (SVAAN), has been modified and converted to sea bed mounted system, and deployed in the shallow waters of South-West Bay of Bengal for noise measurement and for source localization.

NIOT has been active in transferring its technology to the industry for production. Technology for Recombinant ectoine from deep sea bacteria for skin care and cosmetic applications has been developed and transferred to industry through NRDC. Technology for Bioremediation of petroleum hydrocarbon and oil spill in the marine environment by deep sea microbial consortia has been developed and transferred to industry.

In the field of ocean observations, NIOT has made significant contribution with the buoy network and HF Radar. The OOS Group celebrated the Silver Jubilee function together with 29th NIOT Foundation Day on 14th November 2022. Commemorating OOS Silver Jubilee occasion, a book titled, “Rise of National Data Buoy Programme in Indian Seas” was released by Dr. M. Ravichandran, Secretary MoES. OOS Team has successfully established an Indigenous Tsunameter Test Facility at OOS, during March 2023 under Atmanirbhar Bharat Abhiyaan. Deployment of first Iridium communication-based buoy and introduction of first indigenized induction cable for sub-surface mooring is worth mentioning. NIOT moored buoys captured the signals of Severe Cyclonic Storm Asani (May 2022) and Cyclonic Storm Sitrang (October 2022) in the north Indian Ocean and provided real-time observations. From this data, critical information on Tropical Cyclone Heat Potential (TCHP) was provided to IMD that helped in issuing cyclone warnings.

State of the art, HF Radar are being maintained in ten remote locations along Indian coast and data being collected. Significant progress has been made in the EEZ program with bathymetry data being collected along the east coast of which presently data collection along Andhra Pradesh coast is completed.

NIOT’s research vessels provide floating infrastructure to its research activities. HMoES reviewed the scientific capabilities of the Ship & praised the valuable contribution of the Research ship towards enhancing the knowledge on oceans & collection of valuable data. SBT team onboard Sagar Nidhi successfully tracked the trajectory of the launch vehicle and confirmed the separation event of satellites GSLV/Mk-III launched from Satish Dhawan Space Centre [SDSC], Sriharikota launching station.

It is a matter of pride NIOT plays a major role in 4 of the 6 verticals of the Deep Ocean Mission of Government of India. The highly acclaimed Deep Ocean Mission (DOM) activities have been making commendable progress steadily with a lot of success as the manned submersible, ‘Samudrayaan’ is making steadfast progress towards its final testing in offshore waters as the human support and safety system, control system design configuration, emergency system design document, concept of operations, and personnel sphere penetrator configuration have been approved by the certification agency DNV. Pressure balanced oil filled 6000 m depth rated 148V-100kWh and 29V-20 kWh batteries, 500 m depth rated Acrylic view port, communication systems (DNV-certified) were realized, commissioned, and tested in NIOT. Further I am happy to add that sea trials of the self-propelled light-weight Seabed Mining Machine, Varaha-1 (V1) was conducted for nodule collection and pumping in depths over 3100m in the Bay of Bengal as part of seabed mining component. Testing and qualification of 350kW high pressure pump completed for the sub-sea application and slurry entrainment system of subsea nodule feeder in mining system. The Autonomous Underwater Vehicle (OMe 6000) operational capability was realized and exploration sea trial was completed in 5271m water depths in PolyMetallic Nodule (PMN) site, in the Central Indian Ocean. It is my pleasure to share that, a Workshop on developing the Regional Environmental Management

Plan (REMP) for the Indian Ocean (REMP-IO) was jointly organized at NIOT by the International Seabed Authority (ISA) and NIOT with large participation from member countries of ISA, experts and stakeholders from across the world.

The pneumatic sample transfer system has been upgraded by integrating the hydrostatic pressure generator to the serial dilution system for transfer of samples in-situ conditions up to 35 MPa.

For the establishment of Advanced Marine Station for Ocean Biology, collaboration with various Organizations / Institutes is being undertaken. A total of seven major thrust areas with 48 potential sub-themes were identified and the proposal for collaborative research has been invited through an Expression of Interest by MoES.

During August 2022, Dr. Jitendra Singh, Hon'ble Minister of State (Independent Charge) of the Ministry of Earth Sciences and Ministry of Science & Technology, visited Sagar Anveshika at Chennai Port and hoisted Tricolour onboard ship as part of 'Har Ghar Tiranga, Har Jahaj Tiranga'. The Hon'ble Minister reviewed the scientific capabilities of the ship & praised the valuable contribution of the research ship towards enhancing the knowledge on oceans & collection of valuable data.

The Seafront facility is involved in creating infrastructure for facilities such as Ballast water Treatment Technology, work has been entrusted with CPWD for construction of approach trestle to carry sea intake water pipelines and RCC tanks.

The Technology transfer to the industry includes, A saline water lantern; Technology for recombinant ectoine from deep sea bacteria for skin care and cosmetic applications; Technology for Bioremediation of petroleum hydrocarbon and oil spill by deep sea microbial consortia.

The Institute has been providing technical services, knowledge transfer and technology transfer in the field of Ocean to Public Sector as well as Private sector Organizations, which includes Government Departments of various Coastal States, ISRO, DGLL, L&T Defense, and Shell etc.

The pillars of NIOT administration viz., Finance & Accounts, Stores & Purchase and Establishment & Personnel have been facilitating NIOT's research programs and their support is invaluable. The efforts of the Estate and Maintenance section in the upkeep and maintenance of the NIOT Campus is laudable. Efforts of the NIOT Computer Maintenance Cell in upkeep and maintenance of the network is highly appreciated.

A number of patents have been filed and some of the earlier filed patents have been awarded. Matured technologies were transferred to the industry in association with NRDC.

Backed by a team of highly motivated and dedicated colleagues, campaigns such as Swachhata Pakhwada, Vigilance Awareness, Rajbhasha, Yoga Day were carried out with great fervor in letter and spirit at NIOT.

The constant support and encouragement provided by Secretary-MoES, Programme Division, Integrated Finance Division and other officials of the MoES are gratefully acknowledged. Suggestions and directions from Chairman and members of the Governing Body, the Scientific Advisory Committee and the Finance Committee have been helpful in steering NIOT towards its goals.

The efforts that went into collating information for preparation of this Comprehensive Annual Report and contributions of all concerned are noteworthy.

NIOT reaffirms its commitment to designing, development and demonstration of indigenous technologies for the sustainable exploration and harvesting of ocean resources.

Thank you.

(G.A.RAMADASS)

CONTENTS

1. SCHEMES BEING HANDLED

The projects / schemes currently handled by NIOT can be broadly classified under the following areas of application.

I. Deep Ocean Mission

- Development of Integrated Mining System for Mining Polymetallic Nodules from 6000m (Vertical 1)
- Development of Manned and Unmanned Underwater Vehicles (Vertical 1)
- Deep sea microbial biotechnology (Vertical 3)
- Energy and freshwater from the ocean (Vertical 5)
- Establishment of advanced marine station for ocean biology (Vertical 6)

II. Ocean Services, Modelling, Application, Resources and Technology (O-SMART)

(i) Ocean Technology

- Energy (OTEC) and Freshwater
- Development of Technologies for Offshore Structural components
- Coastal Engineering
- Coastal Processes
- Ocean Science and Technology for Islands
- Establishment of Ballast Water Treatment Technologies – Test Facility (BWTT-TF)
- Marine Sensor Systems
- Ocean Acoustics
- Ocean Electronics
- Seafront Research Facility
- Studies based on Gas hydrate Exploration and Technology development for its exploitation

(ii) Observations

- Moored Ocean Observation Network (MOON)
- High Frequency (HF) Radar Network

(iii) Vessels

- Operation and Maintenance of Research Vessels

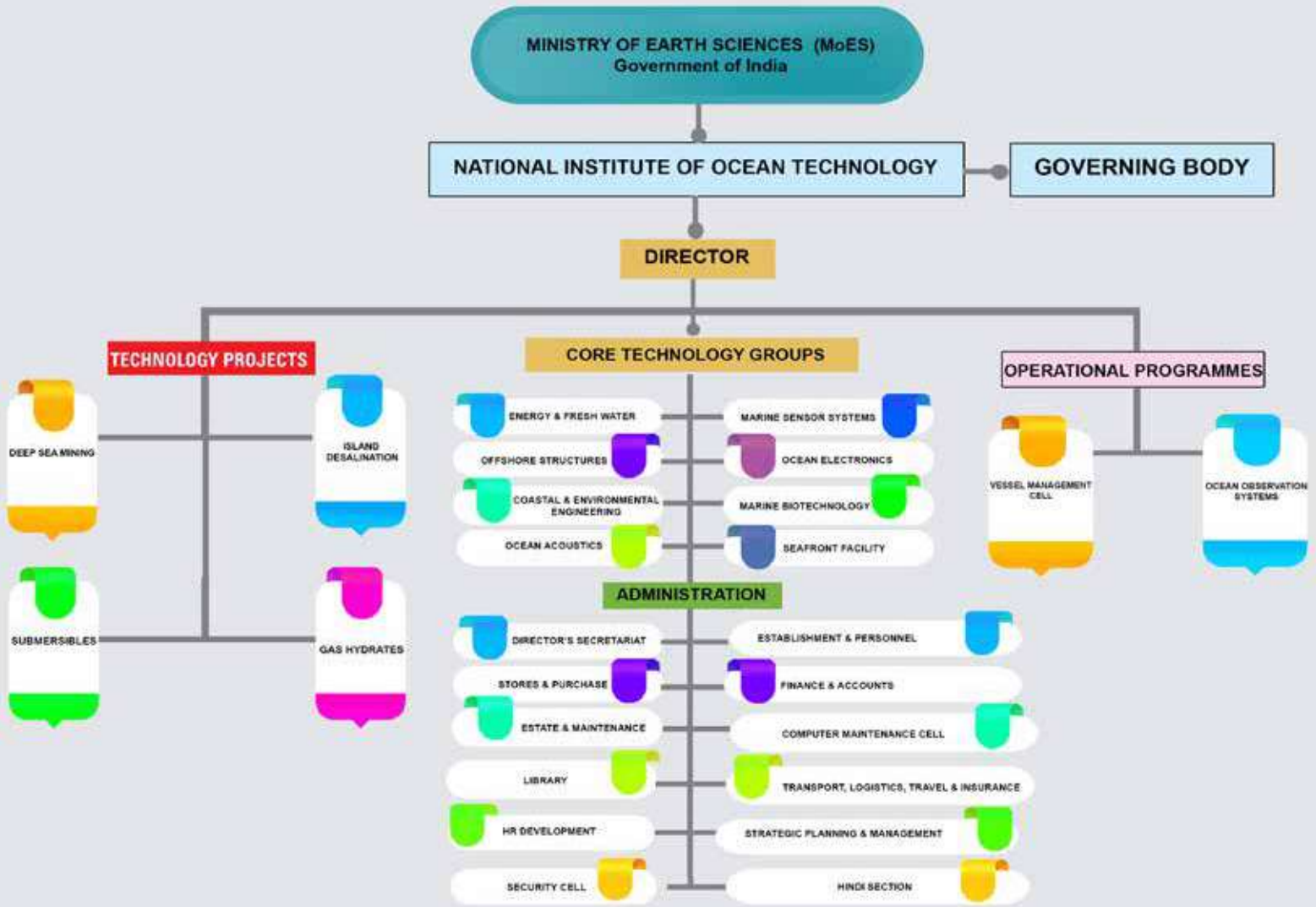
(iv) EEZ Surveys

- Shallow water bathymetry

These schemes can be further classified into technological groups based on their functions, output, significance and societal impact. The classification and objectives of the projects / schemes are discussed in the following section.

The Director is the Head of the institute and all the Operational, Core technology research, administration and infrastructure groups report to the Director as shown in the organization chart.

ORGANISATION CHART



2. MAJOR ACCOMPLISHMENTS OF THE YEAR 2022-23

1. DEEP OCEAN MISSION

- Sea trials of the self-propelled light-weight Seabed Mining Machine, Varaha-1 (V1) were conducted for nodule collection and pumping depths over 3100m in the Bay of Bengal.
- Design of Indian manned submersible MATSYA 6000 has been completed. Human support and safety system, control system design configuration, emergency system design document, concept of operations, and personnel sphere penetrator configuration have been approved by the certification agency DNV for manned submersible.
- Pressure balanced oil filled 6000 m depth rated 148V-100kWh and 29V-20 kWh batteries, 500 m depth rated Acrylic view port, communication systems (DNV-certified) were realized, commissioned, and tested in NIOT.
- Exploration of PolyMetallic Nodule (PMN) site at Central Indian Ocean was carried out using Autonomous Underwater Vehicle (OMe 6000) at 5271m water depth.
- Knowledge workshop in 'Deep sea mining technology' was conducted at NIOT with the participation of major industries from India.

II. OCEAN SERVICES, MODELLING, APPLICATION, RESOURCES AND TECHNOLOGY (O-SMART)

(i) OCEAN TECHNOLOGY

- A surface buoy with a deep water mooring anchored at 1200m depth was deployed near Kavaratti island to collect the current and temperature values at various water depths at the location.
- Orders were placed for "Supply and Commissioning of plant equipment", "Supply and welding of HDPE pipe", and "Civil works" for OTEC plant at Kavaratti and work has commenced at the project site.
- A saline water lantern predominantly meant to be used as a lamp was developed in-house. It can also have a mobile charging device, which will make it very useful in disaster prone areas for communication.
- Commissioning of 1.5 Lakh liters per day capacity Low Temperature Thermal Desalination plant in Amini Island (July 2022) and Kadamat Island (February 2023) in UT Lakshadweep completed
- Hon'ble President of India Smt. Droupadi Murmu, inaugurated the Kalpeni and Amini LTTD plants on 18th March 2023.
- A Memorandum of Understanding (MoU) was signed between Department of Water Resources, Government of Odisha and National Institute of Ocean Technology, Chennai for "Providing Technical Guidance and Design & Drawing of Climate Resilient Coastal Protection Measures for the State of Odisha".

- Underwater inspection of damaged Eastern Breakwater of Mangrol Fishery Harbour, Gujarat was undertaken using first of its kind 3-D state of the art high resolution sonars.
- Expert Appraisal Committee has given Environmental and Coastal Regulatory Zone clearances for the measures proposed by NIOT for Sustainable opening of Cooum, Kosasthaliyar and Adayar river mouths. NIOT has been providing technical advisory services to Water Resources Department, Government of Tamil Nadu for the creek opening measures.
- Indian Coastal Inlets Restoration Program web portal was launched by the Secretary, MoES.
- Development of Deep Sea Autonomous Underwater Profiler (DAUPD) operable up to 5000m depth is in progress with indigenized 1000 CC variable buoyancy engine.
- Drifting buoys with INSAT communication have been indigenized and the technology has been transferred to 4 Indian industries including L&T Defence, Visakhapatnam. INCOIS, MoES is in the process of procuring Drifting Buoys from the licensed industries.
- Indigenization of capacitively coupled conductivity measurement based CTD sensor with trial production of 4 units is in progress.
- A small category heavy lift type Drone for marine applications has been customized. Field data collection was carried out along Pamanji – Andhra Pradesh coast. Support was provided to IIITM – Pune (MoES) for performance observation of Air Quality Index parameter sensors. A field fly test and data collection up to 120m vertical height near East coast – Mahabalipuram was undertaken.
- 'C' profiling system operable up to 500m depth has been developed and field demonstrations were carried out.
- A prototype Underwater Acoustic Telephone Unit has been developed and successfully demonstrated for two-way voice communication in the Acoustic Test Facility (ATF).
- A Networkable Digital Hydrophone Array has been realized and demonstrated in the Acoustic Test Facility (ATF). A patent has been granted for the same.
- CAATEX Data retrieval: Scientific Officers from the Ocean Acoustic Team were deputed to Longyearbyen, Arctic to carry out data retrieval from the deployed acoustic recorders incorporated with Coordinated Arctic Acoustic Thermometry Experiment (CAATEX) mooring.
- A newly developed Ambient Noise Measurement System (ANMS) with a pair of hydrophones incorporated with the OMNI mooring in Bay of Bengal was retrieved during 3/2/2023 which consists of 5 months of noise records.
- The Shallow Water Acoustic Vector Sensor Array AutoNomous System (SVAAN), has been modified and converted to sea bed mounted system, and deployed in the shallow waters of South-West Bay of Bengal for noise measurement and for source localization.

- Technology for Recombinant ectoine from deep sea bacteria for skin care and cosmetic applications has been developed and transferred to industry through NRDC
- Technology for Bio-remediation of petroleum hydrocarbon and oil spill in the marine environment by deep sea microbial consortia has been developed and transferred to industry.

(ii) OCEAN OBSERVATION NETWORK

- Ocean Observation Systems Group of NIOT (OOS) celebrated Silver Jubilee function together with 29th NIOT Foundation Day on 14th November 2022. The Chief Guest – His Excellency Mr. Hans Jacob Frydenlund, Norwegian Ambassador to India and Dr. M. Ravichandran, Secretary, MoES, GOI, appreciated the performance of OOS.
- Commemorating OOS Silver Jubilee occasion, a book titled, "Rise of National Data Buoy Programme in Indian Seas" was released by Dr. M. Ravichandran, Secretary MoES.
- OOS Team has successfully established an Indigenous Tsunameter Test Facility at OOS.
- First Iridium communication-based buoy was deployed during the BoB maintenance cruise and deployed 6G BPR with spherical shaped float for the first time in three locations. First Indigenized Induction cable for sub-surface mooring was also introduced.
- NIOT moored buoys captured the signals of Severe Cyclonic Storm Asani (May 2022) and Cyclonic Storm Sitrang (October 2022) in the north Indian Ocean and provided real-time observations. From this data, critical information on Tropical Cyclone Heat Potential (TCHP) was provided to IMD that helped in issuing cyclone warnings.

(iii) OPERATION AND MAINTENANCE OF RESEARCH VESSELS

- During August 2022, **Dr.Jitendra Singh**, Hon'ble Minister of State (Independent Charge) of the Ministry of Earth Sciences and Ministry of Science & Technology, visited **Sagar Anveshika** at Chennai Port and hoisted Tricolour onboard Ship as part of **'Har Ghar Tiranga, Har Jahaj Tiranga'**. The Hon'ble Minister reviewed the scientific capabilities of the Ship & praised the valuable contribution of the Research ship towards enhancing the knowledge on oceans & collection of valuable data.
- SBT team onboard Sagar Nidhi successfully tracked the trajectory of the launch vehicle and confirmed the separation event of satellites GSLV/Mk-III launched from Satish Dhawan Space Centre [SDSC], Sriharikota launching station. It also transmitted both TM 1 and TM 2 vehicle data to Sriharikota on both east and west beams of GSAT 7 satellite links.
- 5 pairs of HF Radar successfully maintained along Indian Coast

(iv) EXCLUSIVE ECONOMIC ZONE (ECS-EEZ) – NIOT COMPONENT

- EEZ bathymetry surveys have been completed for the coast of Andhra Pradesh.


DEEP OCEAN MISSION

3. DEEP OCEAN MISSION

Ministry of Earth Sciences, Government of India launched the Deep Ocean Mission for the exploration of living and non-living resources in the ocean comprising the following verticals

1. Development of Technologies for Deep Sea Mining, Manned Submersibles, and Underwater Robotics.
2. Development of Ocean Climate Change Advisory Services.
3. Technological innovations for exploration and conservation of deep-sea biodiversity.
4. Deep Ocean Survey and Exploration of Minerals from Hydrothermal Vents.
5. Energy and freshwater from the Ocean.
6. Advanced Marine Station for Ocean Biology

NIOT is the lead participant for verticals 1 and 5 of the Deep Ocean Mission and also plays a major role in verticals 3 and 6.

3.1 DEEP SEA TECHNOLOGIES- DEVELOPMENT OF MANNED & UNMANNED UNDERWATER VEHICLES (VERTICAL 1)

Deep-Sea Technologies (DST) group functions with a mandate to develop technology for the exploration and exploitation of deep ocean mineral resources such as poly metallic manganese nodules (PMN), gas hydrates, hydro-thermal sulphides etc. and also for oceanographic, polar and also industrial applications.

Deep Sea Technology group of NIOT is involved in achieving the following objectives of Vertical 1 of the Deep Ocean Mission (DOM) for the "Development of Technologies for Deep Sea Mining, Manned Submersible and Underwater Robotics".

Design and development of

- A self-propelled Seabed Mining Machine capable of collecting and pumping manganese nodules to intermediate depths, from the water depths of 6000m and develop a flexible riser and high-pressure pumping system for transporting the mined nodules from the ocean floor to the mother ship on the surface.
- 6000 m depth rated Scientific Manned Submersible and Deep water unmanned underwater vehicles and systems.

Background

NIOT is involved in design and development of 6000 m depth rated manned submersible with suitable scientific payloads for exploration, sampling and intervention in deep ocean apart from capacity building.

Design and Development of 6000 M Depth Rated Manned Submersible

Design of of a 6000m depth-rated manned Submersible capable of carrying 3 people with an operating duration of 12h and emergency endurance of 96hrs has been completed. A System Integration Review (SIR) was conducted during July 2022. The objective of the SIR was to examine the system to check for all interfaces of subsystems, and to reduce possible failures.

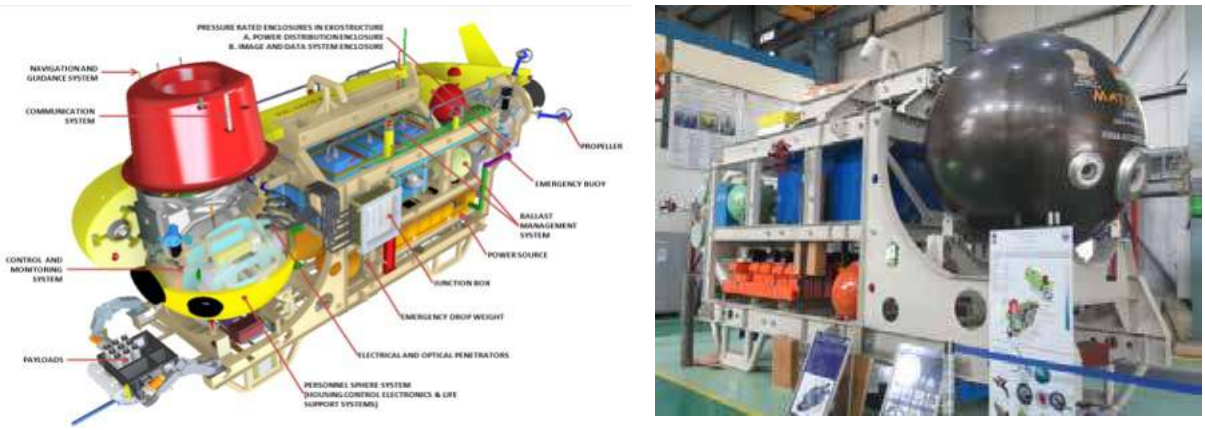
(i) Deep water personnel sphere

Design document for the 2.1m diameter 6000m depth-rated Titanium alloy personnel sphere, prepared by Vikram Sarabhai Space Centre (VSSC), was submitted to the certification agency DNV-GL for approval. The Electron Beam Welding (EBW) facility at LPSC-ISRO, Bangalore, was augmented for higher thick welding. Compression testing of Ti-alloy forged rings to validate the yield strength was completed at VSSC in the presence of NIOT and DNV.

Ti alloy forging process for the 6000 m depth rated Personnel Sphere

(ii) General Arrangement and Concept of Operations

General Arrangement (GA) of the submersible was finalized. The free-board was designed to be 1.5 metre, with a sail above the personnel sphere. The GA and Concept of Operation (ConOps) for nominal conditions were approved by DNV. The final GA along with the weight and buoyancy estimations was provided to IIT Madras, Chennai for model testing. A mock-up frame with model of subsystem/components was realized for checking the interference of the mechanical systems.



Mock-up model of Subsystems placed in the frame

(iii) Ballast and Trim System

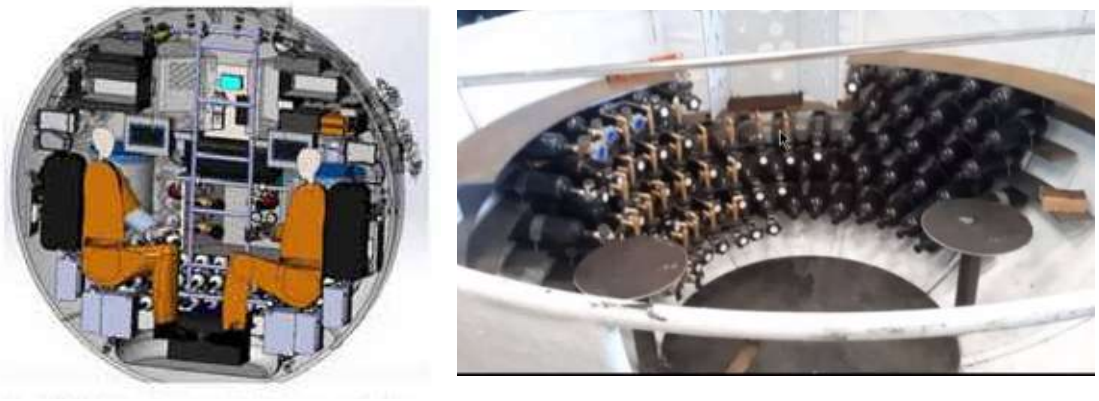
Ballast and Trim system (BATS) enables the following major functions,

- descent /ascent of the submersible at the required velocity (without the aid of propulsion thrusters),
- providing 1.5m of free-board in the surface enabling divers to get on-board and unhook and hook back with the ship crane,
- adjusting weight/buoyancy of the submersible while in operations (with varying water density, payloads and also during collection of samples),
- adjusting trim angles in the longitudinal and traverse axis (for ensuring stability and crew comfort) and providing stability during vertical or horizontal movement.

Design of BATS has been completed and was approved by DNV. Realization of the same is in progress.

(iv) Human Support and Safety System

The Human Support and Safety System (HSSS) inside the personnel sphere was designed to cater to the survival of 3 people for a normal period of 12 hours and 96 hours in case of emergency, the system includes a gallery of oxygen cylinders, carbon dioxide (CO_2) scrubbers, dehumidifier, fire extinguishers, emergency oxygen supply, redundant sensor networks and data acquisition systems. Detailed system was approved by DNV. HSSS with the subcomponents was realized and tested in supplier's facility in March 2023.



HSSS components and oxygen cylinder arrangements

(v) Subsea Batteries

The manned submersible subsystems are powered using Pressure- Balanced Oil Filled (PBOF) Lithium-polymer batteries located in the submersible exo-structure. Li-Po PBOF batteries with DNV certification were realized at NIOT during October 2022 from M/s. ICTINEU, Spain.

(vi) Electrical, Electronics and Navigation Systems

The personnel sphere, in addition to housing 3 people and their life support systems, houses vehicle control, navigation, positioning, communication and 24VDC power converters and

emergency batteries. Power and signal connectivity with the exo-structure was achieved using electric, optical and coaxial penetrators. The power and control networks, forming part of the personnel sphere, were finalized based on Concept of Operation, scientific operational needs, safety, ergonomic standards as approved by DNV. Modeling, Procurement, Assembly, on turnkey basis to an identified developer from Bangalore. Prototype imaging, Data system and Power distribution system were developed and tested in-house. The mechanical design of the Titanium Grade 5 pressure rated enclosures for power distribution, imaging and data system was completed and approved.

Internal arrangement in PS and IDE

(vii) Electro Magnetic Interference (EMI) Studies

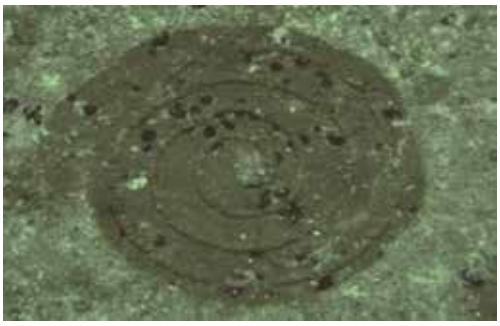
First phase of Electro Magnetic interference (EMI) measurements were completed during September 2022 in collaboration with M/s. Society for Applied Microwave Electronics Engineering Research (SAMEER) at Acoustic Test Facility of NIOT. Test setup with Power distribution system with 148 V DC battery, four thrusters, imaging and data system with camera for second phase EMI studies was developed in-house.

100kWh Li-Po battery commissioned and EMI test setup with IDE and PDE at Lab

Realization of 6000m Depth-Rated Autonomous Underwater Vehicle

A 6000m depth-rated autonomous underwater vehicle, Ocean Mineral Explorer (OMe 6000) was realized from M/s Kongsberg, Maritime, Norway for enabling high-resolution close seabed mapping for deep sea mineral exploration. The Sea Acceptance trials were completed at 3400m depth in Bay of Bengal during November 2022 and OMe-6000 was successfully tested at PMN site, in Central Indian ocean basin (CIOB) at 5271 m water depth in December 2022.

The system was qualified for operation for more than 48 hours at deep sea along with scientific payloads (HISAS, Multibeam, Magnetometer, Subbottom profiler, ADCP), oceanographic sensors (Temperature, Conductivity, DO, SVP, Eh, pH, Methane, Turbidity etc), navigational sensors (acoustic positioning devices HiPAP, acoustic modem, Depth, altitude, obstacle avoidance, Inertial Navigation System, Doppler Velocity Log) and sea bed images / photography using CATHX camera 6 m above the seabed. All collected data were stored in network attached storage devices for further processing.



AUV deployed onboard Sagar Nidhi and manganese nodule image captured at 5271 m depth at mining site in CIOB

3.2 DEVELOPMENT OF AN INTEGRATED MINING SYSTEM FOR MINING OF POLYMETALLIC NODULES FROM DEPTHS UP TO 6000M (VERTICAL 1)

The second objective of Vertical 1 is to develop technologies for deep sea mining and demonstrate an Integrated Mining System (IMS) to collect polymetallic nodules from the seabed at depths up to 5500m – 6000 m at the Central Indian Ocean and to successfully transport it to the surface, in a reliable and sustainable manner.

Background

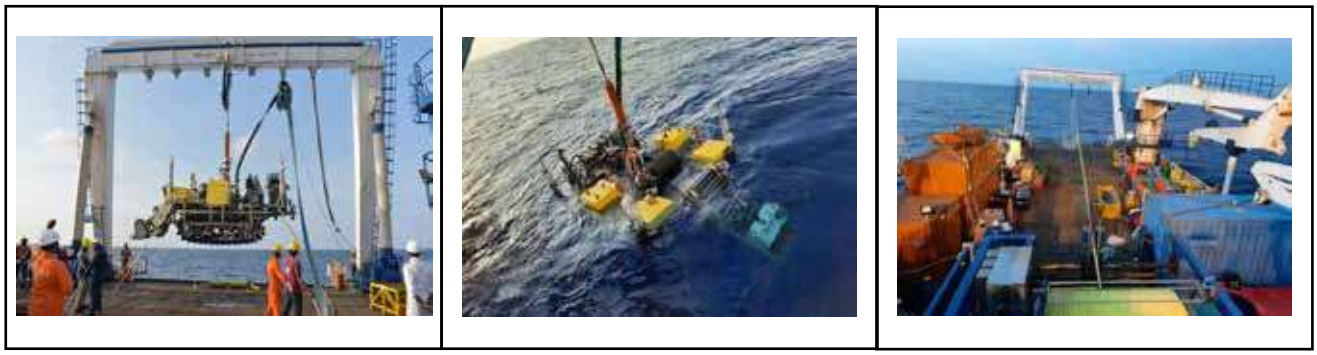
Polymetallic nodules (also known as ferro-manganese nodules) are potato-shaped, largely porous, water saturated nodules found in reasonable abundance, on the abyssal plains of the deep oceans. The major areas of abundance are in the Pacific and the Indian Oceans. These nodules are rich in the principal metals: nickel, copper and cobalt, apart from iron and manganese and are considered to be of economic and strategic importance.

India has been allocated 75,000 km^2 of seabed area with distribution of polymetallic nodules by the International Seabed Authority (ISA), Jamaica for undertaking survey and exploration and related development activities for exploratory mining, through mining tests and trials.

Development of technology for mining deep sea mineral resources is aimed at developing indigenous mining technology to harvest Polymetallic nodules (PMN) from depths up to 6000m. The development work aims at development of an Integrated Mining System (IMS) for pilot demonstration of harvesting PMN from the depths up to 6000 m from the Indian Ocean.

(i) Sea trials of the self-propelled light-weight Seabed Mining Machine, Varaha-1 (V1) for the Nodule Collection and Pumping over 3100m depth at the Bay of Bengal.

The self-propelled light-weight seabed mining machine consisting of nodule pickup, collector and pumping system was deployed in the Bay of Bengal (BOB) for integrity and functional test prior to sea tests at Central Indian Ocean (CIO). The system was deployed to a depth of 3100 m at BOB and tested, keeping the ship in DP. The electro-hydraulic, mechanical, electrical, instrumentation and controls were tested. During the deployment, slurry hose and floats were also connected to emulate the system connections as required during the CIO trials. All the sub-systems performed optimally as anticipated. The system was retrieved back to deck after testing. The system sub-components were designed in light-weight material of titanium to reduce the total weight of the system considering the handling during launching and retrieval. Prior to sea trials the system was extensively tested for the locomotion capability in a sand bed with indigenously developed driven drum and traction system and water tank facility.



Launching and retrieval of Nodule collection system – BOB 2023 – 3000m depth MSL

Integrated tests in water tank facility – NIOT (Mining machine tests)

(ii) Testing and qualification of 350kW high pressure pump to be adopted for the sub-sea application

To pump Polymetallic nodules from the sea bed to the surface vessel, a single stage high pressure positive displacement pump is proposed to pump the nodules from a depth of 5000m-5500m. The capacity and size of pump required to pump nodules from these depths was arrived through extensive calculations and experimental results. A120 bar, 80 m^3/hr discharge, solids twin-piston reciprocating pump was proposed and procured. As there are no manufacturers globally to manufacture such a pump for sub-sea applications, a standard land-based pump of the required capacity and size was procured with the electric motor driven hydraulic power pack unit. The system shall be modified with suitable adaptations

to work in subsea condition by NIOT indigenously. Initially the system was tested in NIOT to analyze its rated operating capacity as part of FAT and acceptance.


Testing of High Pressure Positive Displacement pump

(iii) Installation and commissioning of low frequency Acoustic Positioning system

The "Low Frequency Acoustic Positioning System (APOS) (HiPAP 102 from M/s Kongsberg Maritime, Norway) was installed and commissioned onboard vessel, ORV Sagar Nidhi - for depths exceeding 4000 m. The system was tested at sea for detection and underwater position. The system (APOS) shall become part of ship to accurately locate the position of the underwater vehicle up to depths of 6000m with respect to the ship and shall be extensively used for deep-water mining trials at the CIOB. It is also a critical system to locate the manned submersible at higher depths, exceeding 4000m.

Installation and commissioning of APOS on board Vessel Sagar Nidhi

(iv) Development / Indigenization of high voltage underwater cable connector

Interconnection between different sub-components, sensors and equipment in various sub-sea systems is done through special underwater connectors and cables. These connectors and cables are proprietary in nature, imported, costly and require long lead time to supply. Development/ indigenization of these connector/ cable assemblies are proposed and efforts were taken to develop a 3000V, power connector / cable assembly indigenously at NIOT. The sub-sea cable assemblies and mating connectors have been developed in-house and tested in hyperbaric chamber for 600 bar pressure successfully.

3.3 DEEP SEA MICROBIAL BIOTECHNOLOGY (VERTICAL 3)

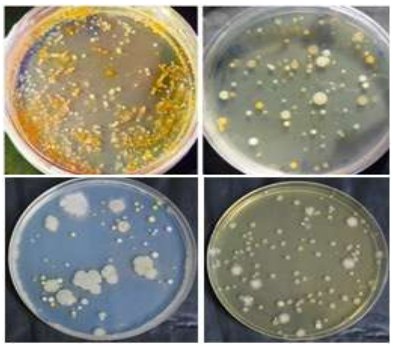
Objectives:

Development of technology for isolation of deep-sea piezotolerant and piezophilic microbes, symbionts and screening for novel biomolecules using culture-based and metagenomic approaches.

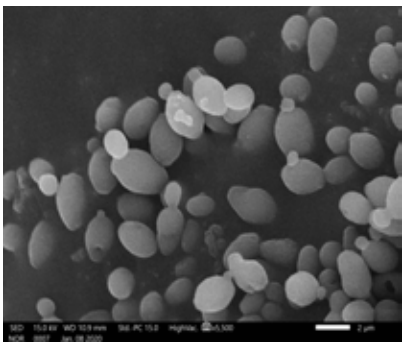
Deliverables include:

- Development of high-pressure retainable sampler and cultivation system.
- Isolation of deep-sea symbionts, piezotolerant, piezophilic microbes
- Screening for novel biomolecules using culture based & metagenomic approaches.
- Creating repository of piezophiles and piezotolerant microbes from deep-sea.

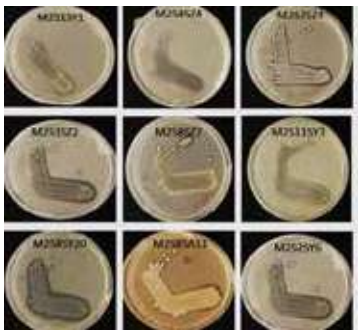
The pneumatic sample transfer module of the high-pressure culture system has been upgraded to a hydrostatic sample transfer system by integration of hydrostatic pressure generator with serial dilution system for transfer of samples in in-situ conditions up to 35 MPa. Water and sediment samples collected from potential sea mounts locations in the Arabian Sea onboard CRV-Sagar Anveshika. A total of 250 bacterial isolates have been isolated and characterized from seamount samples of Arabian Sea and deep-sea water samples in the Indian Ocean. Metagenome based microbiome profiling is completed for 15 water and sediment samples collected from Arabian Sea. Phylogenetic analysis showed affiliation to *Janthino bacterium lividum, Alteromonas macleodii, Acinetobacter Radioresistens, Pseudo alteromonas tetraodonis, Paracoccus nototheniae, Microbacterium enclense and Quipengyunia flava.*



Heterotrophic microbial diversity



Yeast *M. guilliermondii* OYA12



Carbonate Dissolution Activity

Metagenomic DNA clone library with 3331 clones were constructed from seamount sediment samples and the clone library were screened for phosphatase enzyme which has crucial application in molecular biology.

Deep sea oleaginous yeast Meyerozy maguillier mondii OYA12 was identified to contain lipid content of 31 % which holds potential as fish and poultry feed supplement. Deep-sea bacteria Micromonospora sp. showed production of extracellular melanin like pigment which has potential cosmeceutical application. Marine Microbial Information Portal (MMIP) has been developed to curate microbial sequence information with associated metadata. The portal is hosted in NIOT website and is currently under beta testing.

3.4 ENERGY AND FRESHWATER FROM THE OCEAN (VERTICAL 5)

The Ocean Energy and Freshwater component of Deep Ocean Mission (DOM) has the following objectives:

- Detailed engineering design document for high-capacity offshore OTEC-powered desalination plant.
- Performance assessment of critical components such as deep-sea cold-water conduit and mooring system by demonstration in deep sea.

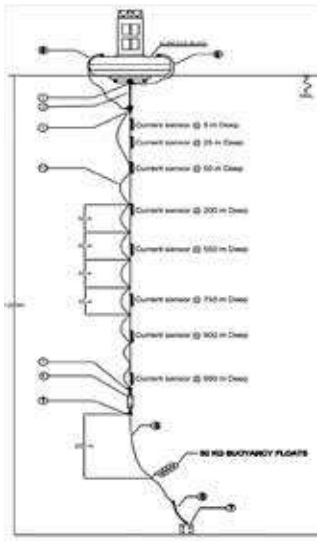
A tender was floated for identifying suitable contractors for detailed engineering design of a high-capacity floating plant for OTEC and Desalination. The proposed offshore plant design shall be powered by open cycle OTEC to cater to desalinate modules and power generation using closed cycle OTEC.

Work towards testing of offshore components for scaled down field demonstration has been taken up. Sizing and design of platform and cold-water conduit bundles is in progress.

A collaborative study with IIT-Bombay on 'Numerical and physical model studies on scaled-down offshore high capacity OTEC-Desalination plant platform' has been undertaken to understand hydrodynamics associated with different offshore platforms for mounting the OTEC-Desalination process components.

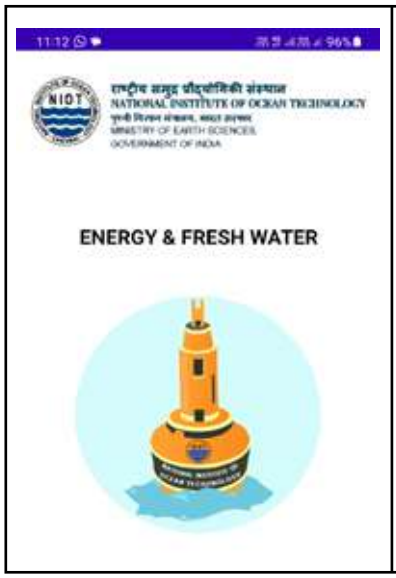
Deep-sea observation buoy off Kavaratti

In order to demonstrate critical offshore components as part of Vertical 5 objectives, various site-specific studies are being carried out. Measurement of parameters such as ocean currents, temperature, and depth along 1000m water depth were undertaken. The measured data will be useful for design of various offshore components. NIOT team successfully deployed a surface buoy with a novel mooring configuration with subsea sensors up to 1000m water depths for the first time for long term in-situ measurements of current and temperature profiles off Lakshadweep Islands in the Arabian sea. NIOT's ORV Sagar Nidhi was used in this deployment during 26-27, Feb 2023.Configuration of the buoy system with these sensors and inductive mooring deployed off Kavaratti is shown. This enables understanding of long-term sub-sea environment towards the installation of the pipeline for the ongoing project at Kavaratti. Hourly current and temperature data corresponding to the varying depths are transmitted through various communication modes and these can be accessed through in-house developed mobile application.

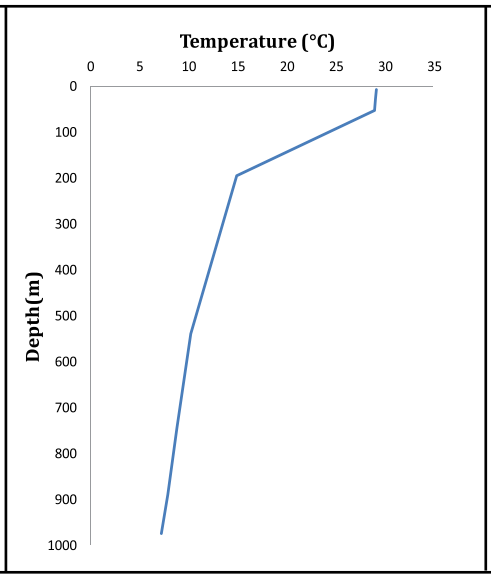


Mooring configuration with current meters

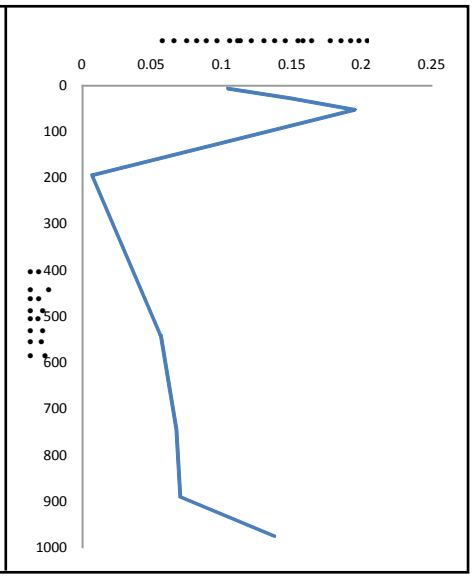
EFW team onboard ORV Sagar Nidhi



Mobile application for current meter buoy



In-situ measured temperature profile at 1000 m depth



Measured current profile at1000 m depth on a typical day

O-SMART / OCEAN TECHNOLOGY PROJECTS

4. OCEAN TECHNOLOGY PROJECTS

4.1 ENERGY AND FRESH WATER

The Energy and Fresh Water group works on developing technologies related to harnessing ocean renewable energies and generating fresh water from the ocean. The focus is on utilizing the renewable energy available from the ocean in the form of waves, currents and thermal gradients and producing high-quality clean drinking water. The primary research areas of the group comprise of :

- Development of technologies for Low-Temperature Thermal Desalination (LTTD) using coolant water discharge from a thermal power plant and offshore deep sea cold water
- Harnessing ocean energy, especially using Ocean Thermal Energy Conversion (OTEC), waves and tidal streams.

Background

The Energy and Fresh Water group of the National Institute of Ocean Technology focuses on harnessing energy from the ocean in the form of waves, seawater currents and ocean thermal gradient to generate electricity and desalinate seawater. The group's mandate is to develop cutting edge technologies that can produce fresh potable water and generate electricity from the ocean. The group is currently working on the following activities :

a) Establishment of waste heat recovery LTTD plant in 2 modules of 1 million litres per day (MLD) capacity at Tuticorin Thermal Power Station.

b) Establishment of an OTEC powered desalination plant of 100 m^3 per day capacity at Kavaratti in UT Lakshadweep.

Establishment of an Ocean Thermal Energy Conversion (OTEC) powered desalination plant of 100 m^3/day capacity at Kavaratti in UT Lakshadweep

Towards the Establishment of an OTEC powered desalination plant of 100 m^3/day capacity at Kavaratti in UT Lakshadweep, three work package contracts viz. 'Supply and Commissioning of plant equipment, "Supply and welding of HDPE pipe", and "Civil works" have been awarded. Detailed design for process components and turbine is nearing completion. Components consist of flash chamber, condenser, turbine, selection of vacuum pump and plant layout is under review. Extrusion of the HDPE pipeline for the entire length was completed and quality checks were successfully carried out by a third party at the contractor's premises in the presence of the NIOT team. These pipes have been supplied to the Kavaratti project site,

Excavation work at project site

HDPE Pipes supplied at Site

and welding machine's testing is being carried out to commence the welding works. Civil works for three sumps are under progress, the material and equipment required for sump construction have also been mobilized to the project site.

Studies on long cold-water pipeline

Deep-sea cold-water pipeline is one of the most critical components for any Ocean Thermal Energy Conversion (OTEC) plant. A 3.8 km long High-Density Polyethylene (HDPE) pipeline of large diameter will be used for conveying deep sea cold water of temperature less than 8°C from a depth of more than 1000 m to the onshore plant. The bathymetry is gentle near the island and becomes steep within couple of hundreds of meters away, thereby making the installation and operation of the pipeline challenging. The pipeline in-place condition takes an inverted catenary shape with one end connected to the bottom clump weight in deep sea and other end to sump near onshore plant. The pipeline can be divided into various sections (on-bottom and buoyant) depending on the position with respect to top sump connection and nature of attachments added to the pipeline. These sections are subjected to varying environmental loads and thus separate methodologies were considered for analyzing the pipeline behaviour to arrive at designs of various weights and attachments. Time domain analyses using OrcaFlex were carried out for this exercise. Several iterations by varying the weight distribution were carried out towards configuration, optimization and installation studies are also being carried out before finalizing the in-place pipeline configuration.

This cold-water conduit could be susceptible to vortex-induced vibrations due to its high aspect ratio and inherent buoyancy. Here, detailed Vortex induced vibration (VIV) analysis is being carried out to estimate the pipes VIV amplitudes, stress and fatigue damage for the optimized configuration.

Establishment of waste heat recovery LTTD plant in 2 modules each of 1 MLD capacity at Tuticorin Thermal Power Station

NIOT plans to set up a Waste Heat Recovery LTTD technology plant of 2x1 MLD capacity at the Tuticorin Thermal Power Station premise in Tamil Nadu. Out of two modules, one module is for producing Industrial quality water for the requirements of the power plant. The other module is for producing drinking water.

The work was split into multiple components. The tender for process components was floated, bids were received, and a successful bidder was identified. The order shall be placed after clearance from MoES. The tenders for other work packages are being prepared.

Saline water Lantern- ROSHNI

Saline water Lantern- ROSHNI

A Saline water lantern was developed in-house. Saline water lantern works on the principle of ionization. Electrical energy is produced when salt water electrolytes react with magnesium alloy (sacrificial anode) inside the device. When a load (LED / mobile charging) is connected to the battery, the electrons are transferred from anode to cathode. The electrodes are of sacrificial material and hence need replacement after around 500 hours of continuous usage. The saline water lantern predominantly is meant to be used as a lamp, however it can also have a mobile charging device, which will make it useful in disaster prone areas for communication. The technology has been transferred to various industries.

Union Minister Dr.Jitendra Singh launched India's first saline water lantern

Technology Transfer of Saline water Lantern

Studies for Baseline Design of 1 MW Offshore OTEC Plant

Shell International Exploration and Production, Inc is funding a baseline design report for a 1 MW net offshore OTEC plant and a screening tool for a 1-5 MW OTEC plant concept. Preliminary studies have already been carried out.

4.2 OCEAN STRUCTURES AND ISLAND DESALINATION

The Ocean Structures group functions with the mandate to develop technologies for offshore structural components and island desalination. Primary focus of the group is

- Establishing 1.5 Lakh liters per day capacity Low Temperature Thermal Desalination plants in the six Islands of the Union Territory of Lakshadweep.
- Feasibility studies on fixed and floating platform for Offshore Wind Turbine.
- Design and demonstration of submerged offshore structure for beach restoration off Puducherry coast.
- Estimation of wave forces (breaking & non-breaking) through wave structure interaction studies.
- Analysis, design and model studies of fixed platforms, floating platforms, riser configurations, moorings and components for deep-sea cold-water pipe of Low Temperature Thermal Desalination Plants in Islands.

Exploration of marine resources requires design of marine structures, pipelines/risers, moorings in deep water and submersibles. The Ocean Structures and Island Desalination group addresses this need for developing offshore components required for most of the projects handled in NIOT as well as the industry. The aim is to provide innovative design solutions through continuous research.

Establishment of Desalination Plants in islands of UT Lakshadweep using Low Temperature Thermal Desalination (LTTD) technology uses the ocean thermal gradient for conversion of sea water into potable water. Implementation of three such plants are completed and are in operation and being maintained successfully by local islanders for the past 18years in Kavaratti and 12 years in islands of Agatti and Minicoy respectively. The major technical challenges include site specific design and installation of about ~1000m long pipeline to draw cold water from about 350m depth and marine structure to draw cold/warm water and to support the pipeline. Now, 6 more LTTD based plants with increased capacity of 1.5 Lakh liter per day has been taken up.

Establishment of 1.5 Lakh liters per day capacity Low Temperature Thermal Desalination plants at Amini, Chetlat, Kadamat, Kalpeni, Kiltan and Androth Islands of UT Lakshadweep

NIOT was entrusted with the task of establishing six LTTD plants with capacity of 1.5 lakhs per day at Amini, Androth, Chetlat, Kalpeni, Kiltan and Kadamat Islands of UT Lakshadweep. As the sea bed topography and operating environment vary in each island, the design of marine structures and cold-water pipe has been carried out to suit site specific conditions. The work for establishing LTTD plants has commenced during 2018.

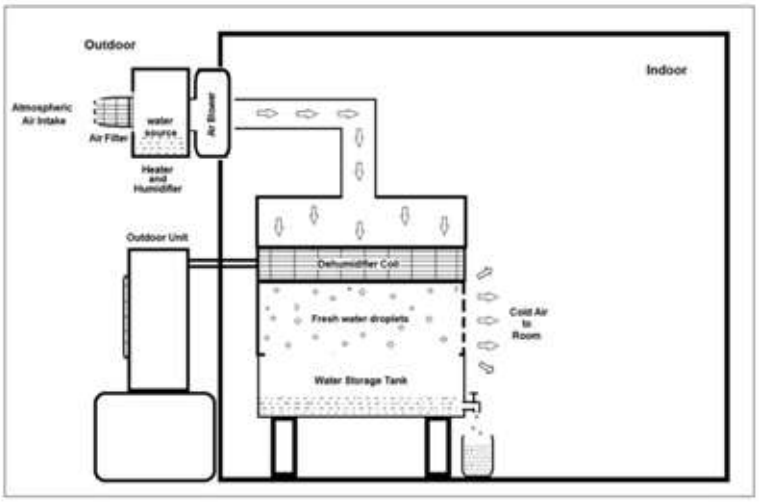
LTTD plant at Amini and Kadamat generated fresh water in July 2022, and February 2023 respectively. Finishing works are in progress at Kadamat Island. Works in Androth, Chetlat and Kiltan Islands of UT Lakshadweep are in progress. Kalpeni and Amini LTTD plants were inaugurated by Hon'ble President of India Smt. Droupadi Murmu on 18th March 2023 in presence of Honourable Administrator, UTL, Shri Praful Patel, Senior officials and People of Lakshadweep, and, Officials of MoES-NIOT.

Low Temperature Thermal Desalination Plant at Kalpeni Island

Low Temperature Thermal Desalination Plant at Amini Island

Water generator from Air including Air conditioner

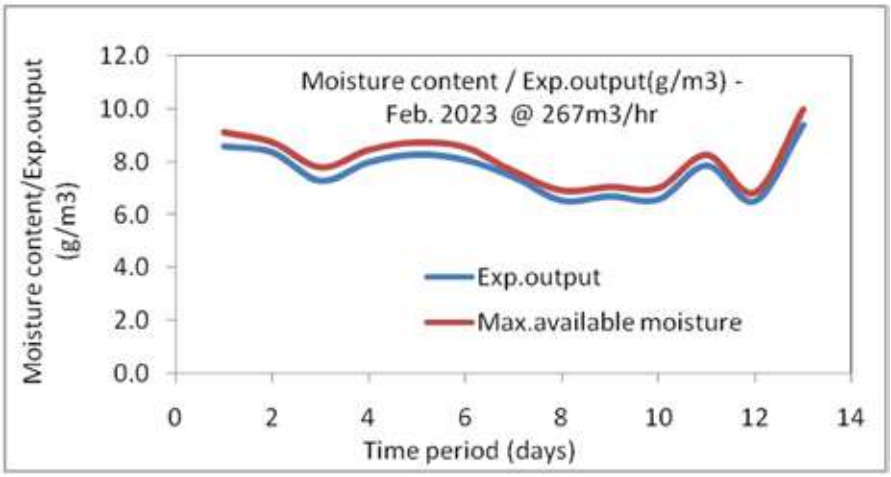
Water Generator from air is a novel concept proposed for generating fresh water from water vapour content in atmospheric air and simultaneous supply of cold air for cooling indoor area. This concept utilizes the de-humidification process for extracting the fresh water from surrounding air. This concept is directly applicable for humid conditions. Passing heated air over brackish/ sea water increases the water content of the air and also the amount of extracted water and hence makes it suitable for dry conditions. As a part of research work,



Block diagram of the water generator system

Experimental Set-up - Air Conditioner and Water Generator

an experimental setup has been established for examining the feasibility of the concept. Initial studies were carried out on process parameters with various options. To enhance the water production, air was passed over the hot water, resulting in generation of water of about 2.3 liters per hour and cooling the indoor area similar to air conditioner.



Experimental results obtained during month of Feb 2023

Feasibility studies on fixed and floating platform for offshore wind turbine

The increased environmental awareness, energy security and depletion of land-based resources have resulted in considering renewable energy options. Presently, the focus is to identify the alternative sources of energy like wind, solar, etc. Offshore wind being pollution free would be an ideal solution to meet this increasing demand as Indian coast is blessed with significant winds. Development of offshore wind in India requires technological development and demonstration projects that will overcome key barriers to offshore wind development, including the relatively high cost of energy, the technical challenges of project installation, the mitigation of environmental impacts, and grid interconnection. So, studies are being taken up to develop innovative structural components and installation techniques using integrated system designs, improved modeling and analysis tools, which will improve the performance and reliability and reduce the costs of offshore wind systems.

Considering the wind potential of the islands of UT Lakshadweep, NIOT is working with MNRE-NIWE for exploiting renewable wind energy to meet the increasing energy demand of the future and to make island self-resilient for power production. Detailed wind resource assessment is required to identify a suitable capacity of wind turbine. Hence it is proposed to install LiDAR based offshore wind data collection instrument for the period of 2 years in Kadamat Island, UT Lakshadweep.

Design and demonstration of beach restoration measure at Pondicherry coast

A near shore wedge shaped structure was implemented by NIOT along with beach nourishment implementation by Govt. of Puducherry. As a result of this coastal protection measure / intervention, a wide beach along Puducherry promenade has formed resulting in restoration of the lost beach after a gap of 30 years.

The coastline of Puducherry is being monitored periodically to evaluate the performance of the installed structure and beach nourishment, through scientific measurements. NIOT is

exploring highly advanced image-based techniques for remote and continuous monitoring of the beach formation process at a finer spatial and temporal scale than what is possible with field measurements. The wedge-shaped structure has been found to be effective in holding the nourished sediments within the protected area thereby maintaining a long and wide beach all throughout the year irrespective of the natural seasonal change in the longshore transport direction. The Government of Puducherry also requested technical support of NIOT for implementation of southern offshore structure.

Beach formation near submerged structure

Wave structure interaction studies

The response of ocean structures to hydrodynamic forces (wave and currents) is nonlinear and complex. The existing standards do not have reliable methods to estimate wave forces on coastal structure. Wave Structure interaction studies were taken up to address such needs and the method to estimate forces on structures through full scale experiments and Numerical Modelling. Full scale experiments are being conducted on intake structure at Agatti Island, where wave and tidal measurements have been recorded since 2012 to 2020 by bottom mounted directional wave recorders which measures both incident and reflected waves. Standardization for estimation of wave loads on marine structures and development of numerical tools for estimation of wave loads is in progress. Based on the inputs from the studies, Indian Road Congress is in the process of evolving guidelines for estimation of wave loads on structures.

4.3 COASTAL AND ENVIRONMENTAL ENGINEERING

The Coastal and Environmental Engineering (CEE) group functions with a mandate to design, develop and demonstrate world-class technologies to bring state-of-the-art technology in sustainable coastal infrastructure development and coastal protection through field experiments and observations, seabed mapping, laboratory studies, innovative materials, numerical modelling studies and comprehensive, detailed engineering designs.

Providing cost effective and reliable solutions for coastal engineering and marine environment related problems specifically tailored for the coast of India is the prime focus of the group with expertise in design, planning and analysis of coastal, port and harbour structures, seabed engineering investigations (bathymetry, topography, geotechnical and geophysical), oceanographic investigations (tides, currents, waves, sediments, and water quality parameters), and impact assessment studies using numerical modelling (hydrodynamic, wave, sediment transport, littoral transport, advection and dispersion, dredge disposal, storm surge, dam break) etc. all integrated under one roof.

Primarily focus of CEE has been in executing the following components:

A. "Ocean - Services, Modelling, Application, Resources and Technology (O-SMART)"

- Performance assessment of coastal infrastructure along the Indian coast to assist in design of environmentally friendly structures for coastal protection.
- Development of design criteria for coastal infrastructure for extreme environmental loadings by assessment of waves, currents, and tide parameters.

B. Sponsored Research Projects for industry and coastal stakeholders.

C. Establishment and Maintenance of Indian Coastal Ocean Radar Network.

D. Geoscientific studies for Exclusive Economic Zone (EEZ) – Shallow water bathymetry survey along East coast of India.

Performance Assessment of Coastal Infrastructure Along the Indian Coast to Assist in Design of Environmentally Friendly Structures for Coastal Protection.

Indian Coastal Inlets Restoration Program

Coastal inlets are confluence between the creeks, estuaries and the open sea. Detailed studies for keeping coastal inlets sustainably open is essential for societal benefits (draining of flood waters, safe keeping of artisanal boats) and ensuring clean water quality at the confluence with the following objectives.

ICIRP Portal launched by Secretary, MoES

1. To carry out scientific studies for keeping the Coastal Inlets sustainably open with a view to increasing tidal prism inside the inlet to enable dilution and mixing.
2. To reliably predict waves, currents, tides and sediment transport around the inlet so as to enable safe keeping of small artisanal fishing boats.
3. Carrying out comprehensive environmental, ecological and morphological measurements at the inlets and within the creeks / estuaries for reliable long-term predictions for assessing assimilative capacity of the system.

Workshops were conducted at Chennai and Kerala for the stakeholders of the coastal zone comprising State Govt. officials (PWD, tourism, fisheries, CRZ) and researchers to disseminate the impacts of closure of coastal inlets and the methodologies / efforts required in keeping them open for sustainable coastal operations and effective flood control. Stakeholders were invited to provide NIOT with potential sites where the ICIRP can be implemented.

One of the primary stakeholders, Tamil Nadu Water Resource Department, Trichy region has requested NIOT to study the 17 inlets of Cauvery basin for sustainable opening of inlets. Field Reconnaissance surveys were carried out for restoration of 17 inlets at Cauvery basin during the month of January 2023 with detailed assessment of the existing conditions of the inlets and the behavior of the inlets of Cauvery basin.

Agniyar inlet at Rajamadam village in Pattukottai taluk was taken on priority for the scientific studies for sustainable inlet opening. Long term shoreline changes of adjoining areas of Agniyar basin are analyzed and the annual and seasonal changes in spit area were calculated from satellite images.

Location of Cauvery basin inlets - Satellite Imagery Analysis for Agniyar River inlet

Development of Shoreline Response Evaluation System (ShoRES)

There is a need for evaluating the response of interventions along the coast for evolving a sustainable shoreline management system. With this objective a comprehensive study on "Shoreline Response Evaluation System (ShoRES)" is being developed to predict shoreline evolution in response to structural interventions and natural coastal processes to plan future shore protection schemes, ports & harbour infrastructure.

Shoreline change analysis for Goa coast from 1972 to 2020

As part of ShoRES, assessment of long-term shoreline changes is being carried out using Digital Shoreline Analysis System (DSAS) of ArcGIS. LISS-4, Cartosat-3 and Google Earth images. Presently analysis has been carried for the coast of Ramachandi and Puri of Odisha and shoreline of Goa state. Nine stretches were identified as eroding along the coast of Goa. Shoreline change model studies are in progress for Goa state.

Eco-friendly (plankton free) coastal water intake structures

Large volumes of seawater are used for cooling water purposes in coastal power plants, desalination plants etc., using intake systems which withdraws plankton rich seawater, which is treated with chlorine to prevent biofouling and when discharged back into the environment are often devoid of planktons thereby affecting the biological environment significantly. With an objective to reduce the impact on planktons, it is proposed to filter the seawater through natural seabed layers which is expected to be plankton free and microbe free. In order to demonstrate the technology, it is proposed to install an experimental plant in the nearshore waters. Currently, laboratory testing of this hypothesis is being carried out.

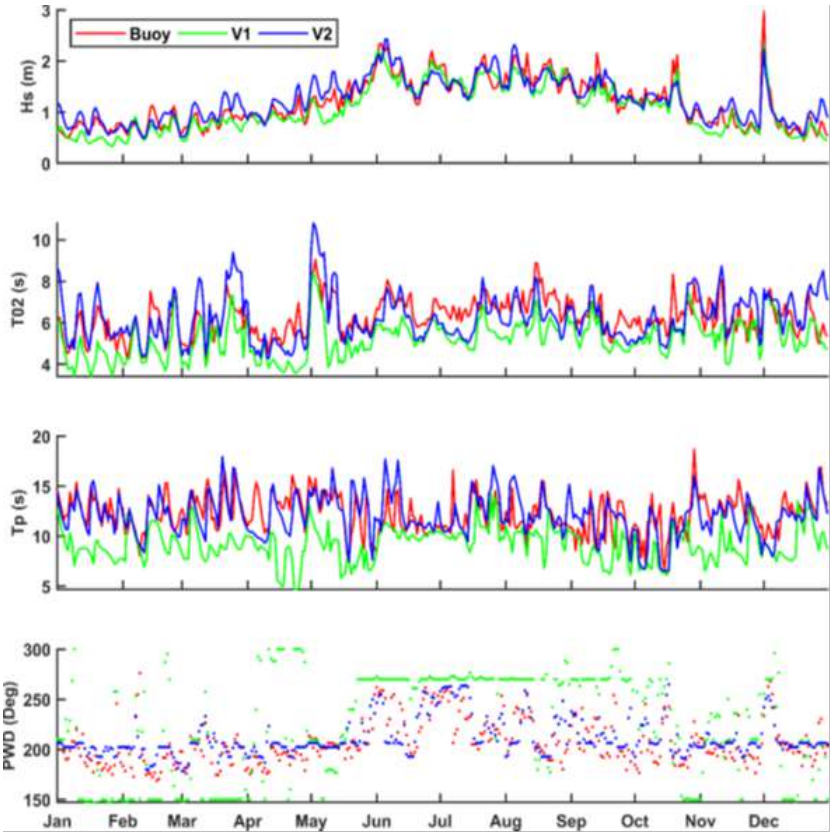
Development of design criteria for coastal infrastructure for extreme environmental loadings by assessment of waves, currents and tide parameters.

Establishment of Indian Coastal Observatory Network (ICON)

There is a need for long-term met-oceanographic measurements in coastal water. This data is useful for assessment of climate change, sea level rise, numerical models and other related coastal parameters. Thus, it has been proposed to establish a coastal observatory network along the coast of India which is an alternative for coastal observation buoys. Environmental loadings were assessed from numerical model studies. Preliminary design of the observatory has been carried out for various configurations and loading cases. Tender specifications for bore hole investigations have been made. Approvals for the observatory location have been initiated.

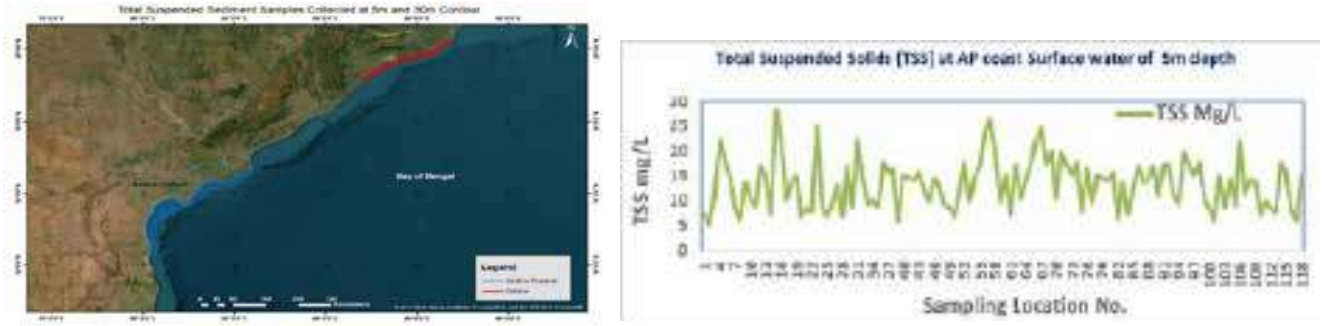
Wave Atlas V.2:

The production run of the Atlas V.2 Wave model for the entire Indian Ocean has been completed for the period from 1995 to 2022. The simulation results have been validated using observed wave data from NIOT, INCOIS, and NIO at 12 locations in the North Indian basin. The Wave Atlas (Atlas V.1) was published in September 2014. Wave model has been revised to include the Lakshadweep and Andaman & Nicobar Islands in the model domain, along with improved model forcings. Based on the sensitivity analysis of the model using different domain configurations, a domain with a southern extension up to 60°S was selected for the Atlas V.2. The atlas V.2 has shown significant improvements in correction, coefficient R, significant wave height, peak wave period and peak wave direction compared to Atlas V.1.



Time series comparison of wave parameters Hs, T02, Tp and PWD at Vizhinjam (A shallow water location in Arabian sea)

Water samples were collected from 0 to 30m water depth along Andhra Pradesh, Odisha and Tamil Nadu coast to study total suspended solid (TSS) matter and grain size distribution for sediment model studies. The analyzed data is being used for validation of the TSS data from Satellite images.

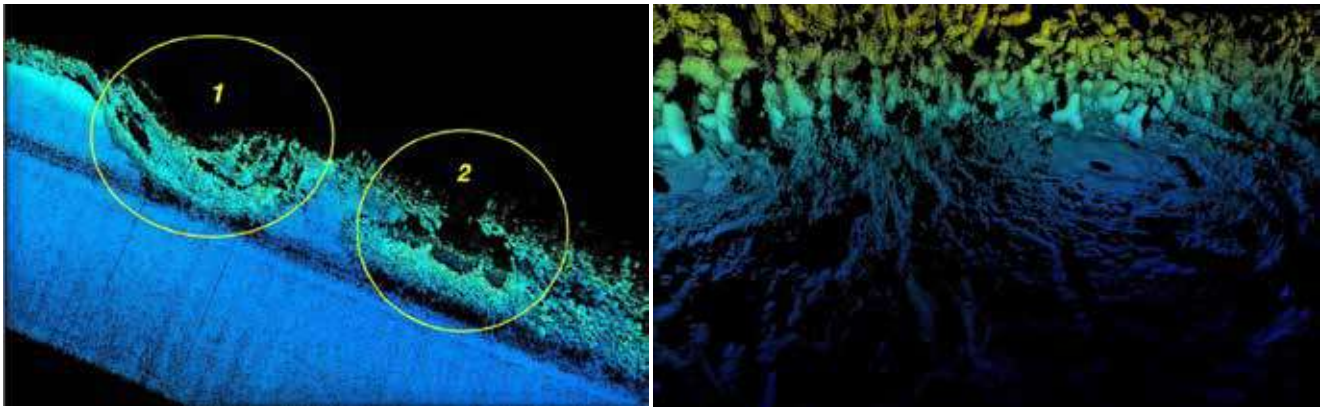


Variation of TSS along the coast of Andhra Pradesh

Sponsored Research Projects:

1. Mitigation Measures to Eastern Breakwater of Mangrol Fishery Harbour, Gujarat

NIOT has carried out assessment of possible causes of damage in the newly constructed Eastern Breakwater in the vicinity of Mangrol in order to provide suitable mitigation measures. First of its kind 3-D underwater investigations were carried out to assess the underwater damage, followed by detailed design as per Coastal Engineering Manual and Rock Manual to suit site conditions. Standard operating procedure for maintenance of breakwater has been made. Wave flume studies were carried out for the designed breakwater section to verify the damage or dislodgement of armor units if any.



Underwater inspection of breakwater with state of art 3D Sonars

2. Short term coastal erosion mitigation measures for Eco-Retreat Konark, Odisha

Konark is known to house UNESCO's World Heritage Sun Temple. The Government of Odisha had established Eco-Retreat-Konark resort near the coast. Operations of Eco-Retreat Konark was severely impacted due to beach erosion. Restoration of Beach at Eco-Retreat Konark was based on soft engineering solutions suggested by NIOT.

3. Technical Assistance and Performance Monitoring for Sustainable Opening of Kosas thaliyar River Mouth / Ennore Creek

NIOT proposed dredging of the creek and constructing training walls in the Kosasthaliyar Inlet / Ennore creek (North Chennai - Tamilnadu) which remains closed for significant part of the year due to deposition of sediments at the creek mouth. Environmental and Coastal Regulatory Zone (CRZ) clearances by Ministry of Environment, Forest and Climate Change has been accorded for the project.

4. Monitoring of Shoreline Changes and Feasibility of Erosion Mitigation Measures for Adani Krishnapatnam Port Limited

Adani Krishnapatnam Port Limited (AKPL) approached NIOT to carry out monitoring studies for shoreline changes and feasibility of shore protection measures for their expansion proposals. The long-term shoreline change studies using satellite imageries has been completed and numerical model studies for feasibility of shore protection measures is in progress.

5. Shoreline change analysis of Vizhinjam coast using satellite images

Following studies have been carried out for Adani Vizhinjam Port Pvt. Limited (AVPPL)

- Assessment of change in shoreline over the 20 km coastline on either side of Vizhinjam port using satellite images and beach profile data for the year October 2021 to September 2022.
- Identification of erosion and accretion hotspots using available moderate and high-resolution multispectral images from remote sensing data and measured beach profile data for the year October 2021 to September 2022.
- Vetting of reports on oceanographic, hydrographic, bathymetric field measured data and numerical model studies provided by AVPPL.

Comparison of 2015 shoreline and beach profile data with 2022, wave analysis for the period from June 2021 to September 2022 and Pre and Post port development/ construction (before and after 2015) scenario of shoreline analysis has been carried out.

The dredging impact study of port area, the water quality and oceanography report are received every month from AVPPL since 2019 till date. The manual measurement of salinity, total suspended solid, turbidity with profiler deployed (Sensor) in buoy data and report is reviewed as per standard quality control procedures.

6. Technical Assistance and performance monitoring for Curved training walls at Cooum river mouth

NIOT proposed construction of curved training walls on either side of the river mouth for the sustainable opening of the Cooum river mouth based on comprehensive scientific studies. NIOT is presently providing technical assistance during the construction stage of the training walls, followed by monitoring the performance post-construction.

4.4 OCEAN SCIENCE AND TECHNOLOGY FOR ISLANDS

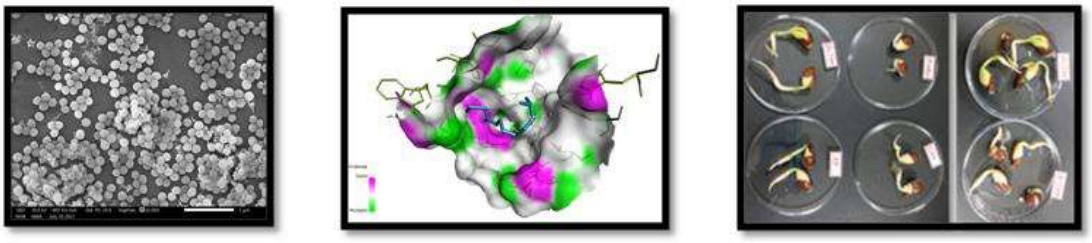
The research and developmental activity of Ocean Science & Technology for Islands (OSTI) group is primarily focused on four major thrust areas viz. Marine Microbial Biotechnology, Marine Algal Biotechnology, Open Sea Cage Culture and Establishment of Ballast Water Treatment Technologies – Test Facility with the following objectives:

- Isolation, culture of marine microbes for the production of novel secondary metabolites for biomedical, industrial and environmental applications.
- Identification of potential algal, development of culture cum downstream processing for the production of nutraceuticals from marine algae.
- Design, development and testing of sea cages suitable for Indian seas, and demonstration of marine finfish farming in open sea cages.
- Establish Ballast Water Treatment Technologies - Test Facility for testing of ballast water treatment systems.

The group is also engaged in monitoring sea water quality in Andaman and environmental impact assessment studies for various developmental programs for the Andaman Administration.

The Ocean Science & Technology for Islands (OSTI) envisages harnessing marine living resources through advanced biotechnology tools towards the development of reliable technology for biomedical, industrial and environmental applications. MBT has also isolated more than 350 marine microbes which include bacteria, actinobacteria, fungi, and yeast, producing a number of biologically active molecules, developed processes for the production of L-asparaginase and ectoine enzyme through recombinant technology and transferred them to industry. Over 250 marine microalgae have been isolated, developed, and various types of culture and harvesting systems have been tested. Technology for the production of nutraceuticals has been developed and transferred to industry. Towards promotion of the blue economy, open sea cages suitable for Indian sea conditions have been developed and culture of marine finfish demonstrated in various maritime states. In order to prevent bio-invasion and conserve native species, a ballast treatment test facility is being established on the NIOT seafront at Pamanji, AP, as per the IMO guidelines.

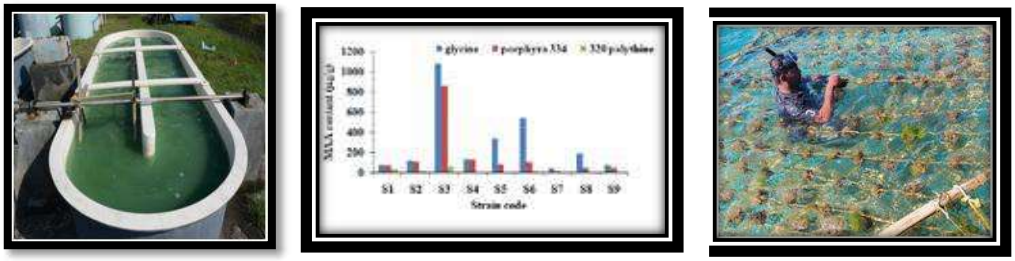
Microbial Biotechnology: Whole Genome Sequencing (WGS) and gene annotation of deep sea actinomycetes Kocuria flava IOS11 has been completed. A novel marine isolate Halomonassp NIOT-EQR_J248 capable of mineralizing 70% Hg II was isolated from equatorial waters. A new path way of Isooctyl thioglycolate mediated bio-remediation of mercury Hg II was confirmed by GC-MS, ICP-MS analysis, mer-gene amplification and molecular docking studies.



(a) Kocuria flava IOS11, (b) GST and isooctyl thioglycolate interaction, and (c) Microbial IAA induced seed germination.

Marine algal biotechnology : Mass culture of Spirulina major was optimized in race way ponds using customized media with only four nutrients. Mycosporine like amino acids (shinorine, porphyra and glycine) with potential cosmetics applications were extracted from cyanophycean algae viz. Synechococcus marinus, Spirulina major, Trichodesmium thieubautii, Phormidium sp. Nostoc sp.

For the production of multiple biomolecules from marine cyanophyceans, bioprospecting was done along the East coast of India from Chennai to Malvan (Maharashtra) on the west coast. Nine strain of marine cyanophyceans isolated were screened for their ability to accumulate biomolecules like C-phycocyanin, zeaxanthin, scytonemin and microsporine like amino acids. The seaweed liquid extracted from Gracilaria edulis was tested at three concentrations for improving the growth of marine microalgae (Chlorella sorokiniana, NIOT-2). Highest biomass and pigment production were noticed at 0.5% seaweed liquid extract supplementation.



(a) Spirulina culture 3 tonne raceways, (b) Concentration of mycosporine for marine cyanophyceans, and (c) Long line culture of Gracilaria edulis

Open Sea Cage Culture: As part of the technology demonstration and promotion of open sea cage culture of marine finfish in west coast, training and demonstration of the open sea cage culture of seabass was carried to fishermen self-help groups at Kumta, Karnatakaas shown in the below figure. The group also extended technical support for cage deployment and culture management of marine finfish, seabass (Latescalcarifer) in open sea cages deployed near Olaikuda for fishermen self-help group. Towards the development of brood stock for seed production sea bass, fish fry was transported from Chennai and were released in nursery cages for rearing deployed in grow out cage at North Bay, Port Blair as shown in the figure. Shooter size fishes (average weight 212g) were segregated and stocked in a separate cage for brood stock development. Model for a suitable site selection methodology for the deployment of the artificial reef for the enhancement of marine fish stock using the GIS tool along the Tamil Nadu coast has been developed.

(a) Training on the cage fabrication, deployment, (b) Cage culture sea bass in Kumta, and (c) Sea bass nursery rearing in Port Blair.

4.5 ESTABLISHMENT OF BALLAST WATER TREATMENT TECHNOLOGIES – TEST FACILITY

Ballast Water Treatment Technologies - Test Facility. The design of the ballast water treatment test facility has been prepared as per the guidelines put forth by the International Maritime Organization (IMO).The trestle-based intake system for drawing raw seawater, a feeder tank of 610 m^3 to supply to the test and control tanks of 285 m^3 capacity in being designed and implemented. As the number of organisms of size ranges (1) >10 - <50µm and (2) > 50µm were found to be lower than the required levels specified by IMO's G8 guideline, a standard test organism culture facility is being developed to culture the desired numbers of organisms.

Drawings of the proposed land-based BWTT-TF at Nellore, A.P.

Construction of the facility (a) set up of feed tank, control and test tanks, (b) Feed tank of 610 m^3 capacity (c) test tank of 285 m^3 capacity and (d) control tank of 285 m^3 capacity

Seawater quality monitoring in Port Blair Bay: Seasonal surveys for seawater quality monitoring in Port Blair Bay has been carried out.

4.6 OCEAN ACOUSTICS

NIOT has developed expertise in the area of Ocean Acoustics in the last 2 decades and development of acoustic systems for ocean applications, ambient noise measurements in Indian deep ocean, coastal waters and Polar regions, and underwater acoustic systems for source localization applications have been achieved. Passive Acoustic Monitoring (PAM) techniques are used to infer about the physical (wind, rain, ice) and bio-acoustic environment and characterizing ocean soundscapes. A vector sensor and array has been developed and demonstrated successfully and is currently being used in Indian coastal waters for coastal surveillance. The group also maintains an NABL (National Accreditation Board for Testing and Calibration Laboratories) accredited Acoustic Test Facility (ATF) for testing and calibration of underwater acoustic transducers.

Development of Ambient Noise Measurement System (ANMS) for Polar Region Measurements

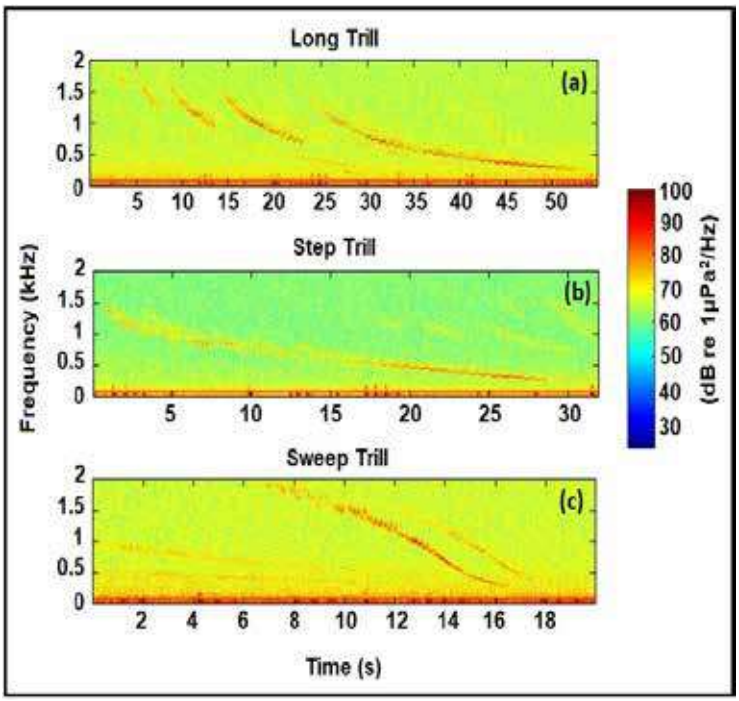
Objective is to develop an autonomous ANMS for in-situ measurements in the Polar region for studying ice dynamics, anthropogenic noise and biological noise through long term measurements, towards understanding climate change.

Polar Data retrieval:

Scientific Officers from the Ocean Acoustic Team were deputed to Longyearbyen, Arctic through NCPOR, during 3-7, Oct 2022 to carry out data retrieval from acoustic recorders incorporated with (i) IndARC mooring system and (ii) NERSC mooring as part of the Coordinated Arctic Acoustic Thermometry Experiment (CAATEX), and retrieval of time series data.

CAATEX Data Processing and Analysis:

An autonomous underwater ambient noise measuring system was deployed at 81° 47.094'N & 022° 00.280'E along with other instruments on one of the oceanographic moorings in the Nansen basin of the Arctic by the Nansen Environmental and Remote Sensing Center (NERSC), as part of the Coordinated Arctic Acoustic Thermometry Experiment (CAATEX). The water depth at this site was 3480 m; and the hydrophone was at a depth of 73 m. The data has been collected during the period of September 2019 to July 2020. The data was recorded for every 1 hr for a total of 36 hrs at a sampling rate of 4 kHz. Different types of trill vocalizations by bearded seal identified and analyzed from acoustic data collected for continuously for 1 hr on May 31, 2020 (UTC 00 hrs) at Nansen basin is shown here.



Trill vocalisation of Bearded Seal from Central Arctic Ocean

Development of Deep Water Ambient Noise Measurement System (DANMS) and Conducting Deep Water Measurements

Objective is to record time series ambient noise data in deep sea Indian Ocean region particularly to gain knowledge on noise variability and noise field in deep water, for acoustic oceanographic applications apart from strategic applications.

Deployment and Retrieval – Indian Ocean:

- A newly developed Ambient Noise Measurement System (ANMS) with a pair of hydrophones has been incorporated with the OMNI mooring and deployed in the Bay of Bengal at BD-11 (13° 28.03' N; 84° 7.12 E) location on 13/9/2022. The same was retrieved on 3/2/2023 with 5 months recorded noise data.

Noise Data Processing and Generation of Acoustic Metrics:

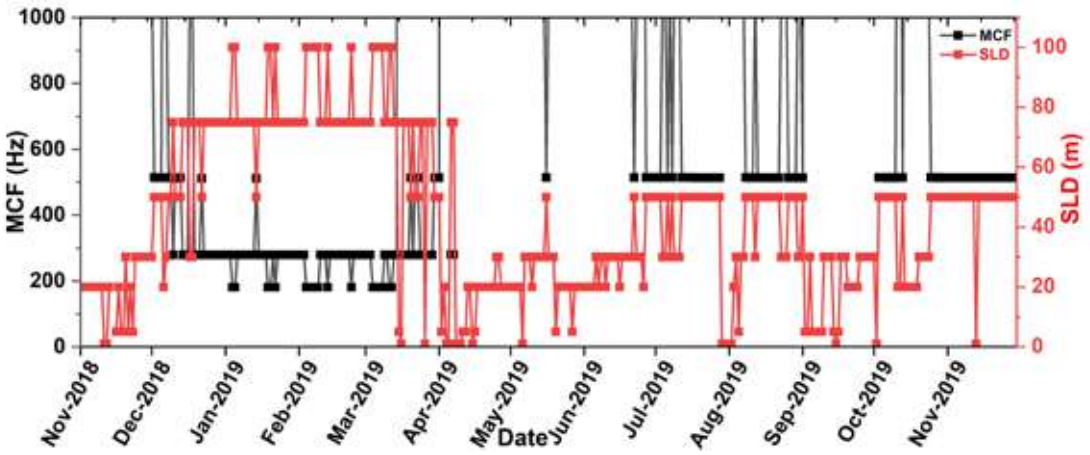
Quality checking and processing of noise data collected from Arabian Sea during Nov 2020 to May 2021 have been completed. Estimated the acoustic metrics such as Sound Pressure Level (SPL) and Sound Exposure Level (SEL) and examined acoustic variability during the measurement period. From the acoustic metrics, the occurrence of noise due to shipping and biologics have been identified and inferred.

The ship noise presence is observed to be fairly high during early morning hours and night. Pertaining to biological signal presence, during early morning and at night, it is observed to be slightly larger when compared to recordings at other times. During Nov 2020 to Jan 2021, the dolphin presence is found to be lesser when compared to other months.

Upper Ocean Dynamics and influence on Acoustic Field – Arabian Sea 2018-19:

Seasonal and monthly variability in Sonic Layer, Depth obtained from estimates of Sound Speed Profiles is studied for a period of 1 year during 2018-19. The sound speed profile is estimated using the data from buoy, satellite and ARGO profiles.

Investigations on the Influence of Sonic Layer Depth and Sound Pressure Level is being carried out. Towards this, SST, SSS, eddy characteristics and sea level anomaly at the site for a year was examined.



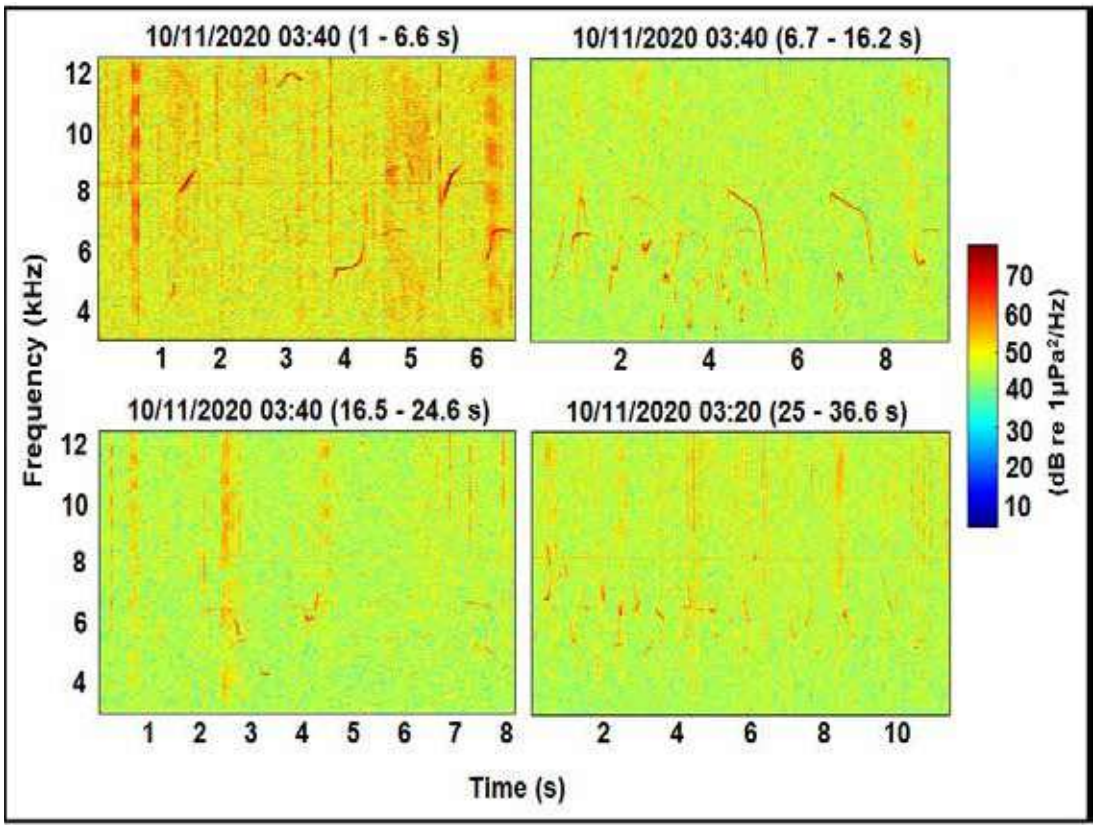
Minimum Cut off Frequency pertaining to Sonic Layer Depth at the measurement location.

Bioacoustics Identification:

Bioacoustics Identification of marine mammals' species in the south eastern Arabian Sea has been taken up for Arabian Sea during 2020-21 and the features in vocalization pattern is being studied. Extraction and description of different whistle types of bottlenose dolphins has been completed. A research paper on this identification is submitted in National Symposium on Acoustics.

Bottlenose dolphins are aquatic mammals that are common, cosmopolitan members of the family Delphinidae, the family of oceanic dolphins in the genus Tursiops. Little is known of the whistles produced by bottlenose dolphins in the Northern Indian Ocean (NIO). From November 2020 to May 2021, NIOT used an autonomous Passive Acoustic Monitoring (PAM) system to collect time series measurements of ocean ambient noise in deep water at AD09 location. The underwater ambient noise data is recorded by an omnidirectional hydrophone once every 3 h with a sampling duration of 75s in the frequency range of 0.05–12.5 kHz with a sampling rate of 25 kHz. Sound files were displayed as a spectrogram with a frequency range of 3-12.5 kHz.

Each ambient noise recording segregated into blocks of few sec duration and signals with similar vocalization pattern have been identified and the same is validated using supplementary sources. The number of occurrences for specific sound type is arrived at towards feature recognition.



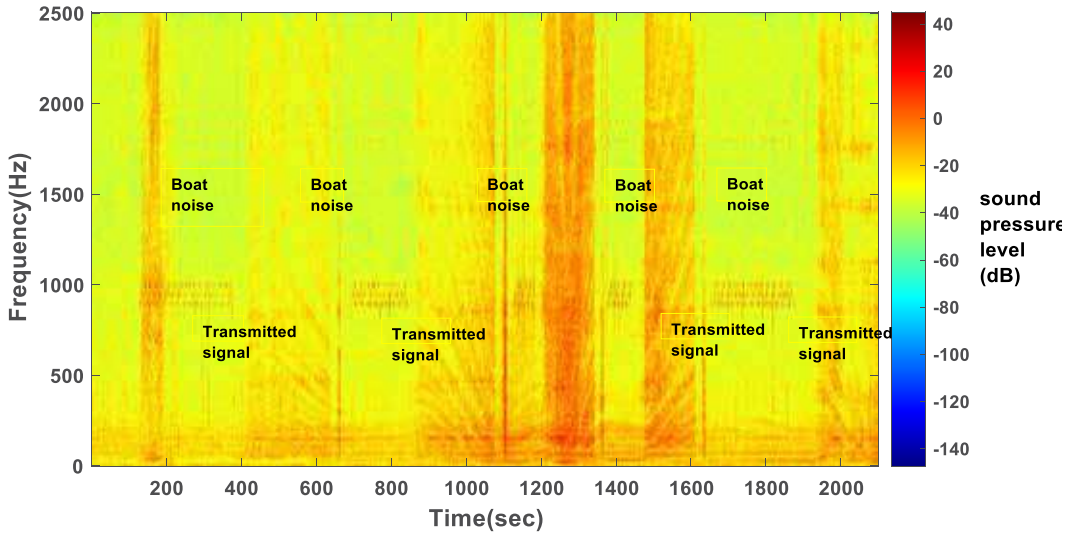
Dolphin whistles recorded by the Deep-Sea Ambient Noise Measurement System in Arabian Sea.

Development of Coastal Surveillance System Using Vector Sensor Array

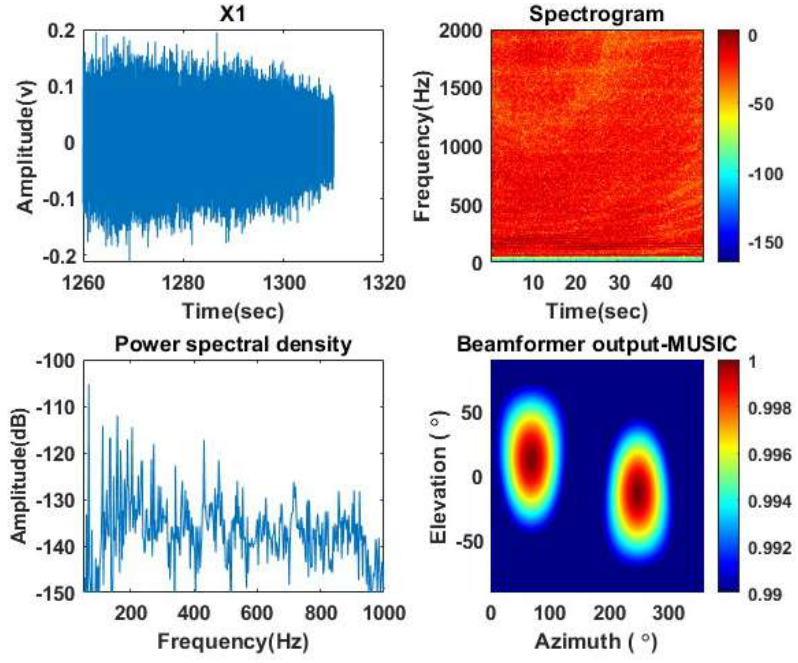
Objective is to develop a coastal surveillance system using vector sensor array.

Field experiment conducted during August 2022

Shallow Water Acoustic Vector Sensor Array AutoNomous System (SVAAN): The vector sensor array system is modified, configured as sea bed mounted system, and deployed as a bottom mounted unit in the shallow waters of South-West Bay of Bengal to measure the noise from boats/ships and to localize the source. The acoustic data is analysed and Direction of Arrival (DoA) is estimated using Multiple Signal Classification (MUSIC) algorithm for source localization and performance of SVAAN is studied. Also, an acoustic source of 1 kHz was transmitted and received by SVAAN for cross verification of results.



Signal acquired from vector sensor for 35 minutes duration



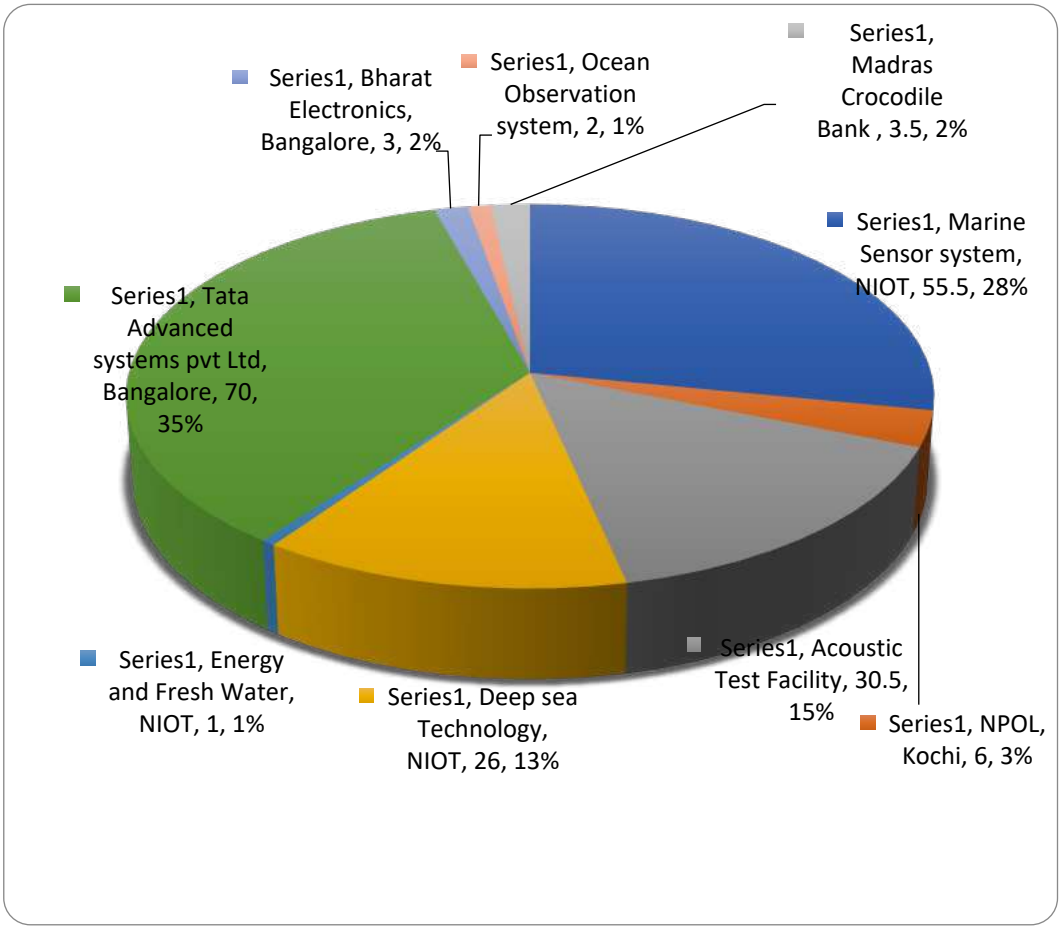
Boat propeller noise captured by SVAAN system (a) X1 signal (b) spectrogram (c) Power spectrum and (d) Bearing angles

Field experiment conducted using Sagar Tara :

VSA system was deployed as a moored system availing Sagar Tara, in the shallow waters of Bay of Bengal, consisting of navigational marker buoy with solar lantern, subsea buoyancy floats, vector sensor array, compass, camera with housing, data acquisition system with battery package and sinker weight. A known source experiment was conducted by running a boat with the maximum distance of upto 10 km from ship Sagar Tara. The data analysis is in progress.

Upgradation and Maintenance of Acoustic Test Facility (ATF)

ATF is extensively utilized by Marine Sensor systems, Deep sea technology, Ocean Electronics, Energy and Fresh water groups of NIOT. Tata Advanced systems Ltd, Bangalore, National Physical and Oceanographic Laboratory, Kochi and Indian Institute of Technology Delhi have used ATF for calibration of hydrophones and system performance testing. In the period April 2022 to March 2023, a total of 198 days were utilized by internal groups of NIOT and external organization.



4.7 MARINE SENSOR SYSTEMS

The focus of the group is :

- To design and develop indigenous Underwater Acoustic Telephone (UAT) for manned submersible operating at 6000m depth.
- To design and develop indigenous underwater acoustic imaging systems.
- To design and develop wide band underwater acoustic transducers and hydrophone arrays.
- To establish and maintain a test facility of excellence to provide support for various projects of NIOT.

The group has successfully developed indigenous underwater acoustic transducers and systems and holds a number of patents and publications. With the expertise gained, development of further advanced systems for deep-sea long-range communication and imaging are being carried out. The group has also attracted the attention of Public sector units like Bharath Electronics Ltd (BEL, Bangalore) and signed MoU with BEL for products of mutual interest.

Development of Indigenous Underwater Acoustic Telephone (UAT)

The group has initiated development of the Indigenous Underwater Acoustic Telephone (UAT) to be used in the manned submersible upto 6000m depth. Acoustic Telephone is the only means of inter-personal communication between the submersible at 6000m water depth and the surface ship and hence, is an essential system for deepwater manned submersibles.

Single Sideband Suppressed Carrier (SSB) modulation technique is used for realization of underwater acoustic voice communication and the concept is proved by conducting experiments/ simulations/ trials/ tests in ATF tank. Design and Development of Stand-alone Digital Signal Processing (DSP) based Underwater Acoustic Telephone, which is suitable for marine environment is in progress. The following activities are in progress.

- Demonstration of two-way underwater acoustic voice communication using MATLAB GUI with Laptop.
- Design of Digital Signal Processing based Acoustic Telephone unit
- Development of Stand-alone DSP based Prototype hardware unit.
- SSB Modulation/Demodulation Algorithm implementation in DSP
- Demonstration of DSP based stand-alone hardware unit with basic functionalities.
- Fabrication of MIL grade Acoustic Telephone Hardware units suitable for marine environment for 500m operating depths

Two-way Underwater Acoustic Voice communication was demonstrated using Laptop with MATLAB GUI and Proto type DSP based stand-alone hardware unit with basic functionalities

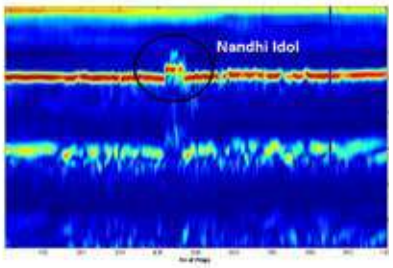
Demonstration of two-way acoustic voice communication

Prototype DSP based stand-alone acoustic telephone unit

Subsystems inside the prototype stand-alone unit

Development of Indigenous Synthetic Aperture Side Scan SONAR (ISASS)

The objective of the project is (i) to design and realize sonar that can provide high-resolution (decimeter level) images of the seabed and underwater objects and (ii) to detect the image of the objects on the seabed with range independent resolution. For the proof of concept, a low frequency range (4-12kHz) system has been realized with indigenously developed NIOT-BEL transducers. The system has been tested in a pond for detecting objects and later a preliminary sea trial has also been carried out. The images were generated during the pond tests.



The image generated during the preliminary sea trial off Chennai

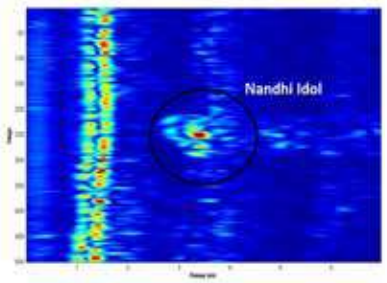
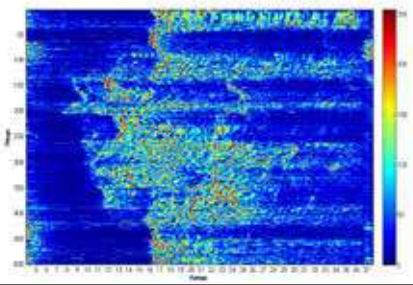


Image of the object detected during pond test



Side scan view of the shipwreck during preliminary sea trial

Further improvement in signal processing is under progress. The sourcing of sub components for the realization of the originally proposed sonar operating at 100 kHz frequency range is also in progress.

Development of Networkable Digital Hydrophone Array

A networkable digital hydrophone array has been realized and successfully tested and demonstrated in the Acoustic Test Facility.

Conventional hydrophone arrays give an analog output which is prone to noise pick-up, especially when the signal has to be transferred to long distances where the data acquisition devices are placed. This problem is addressed in the digital hydrophone array, where a multi-channel simultaneous sampling Analog to Digital Converter (ADC) is incorporated in the array itself. Currently the array has eight hydrophone elements and hence, an eight channel ADC is used in the array for the digitization. This results in simultaneous sampling of the hydrophone outputs close to the elements. The array also houses a built in Ethernet streamer to transfer the sampled data to longer distances, typically 100 m. Data can be transferred to more than 100m, by replacing the Copper Ethernet with optical Ethernet. The data is transferred over Ethernet through User Datagram Protocol (UDP). The timing of sampling, digitizing and the Ethernet streaming are handled by a built in Field Programmable Gate Array (FPGA) which is incorporated in the array.

Networkable Digital Hydrophone Array

Networkable Digital Hydrophone Array during demonstration in ATF

4.8 OCEAN ELECTRONICS

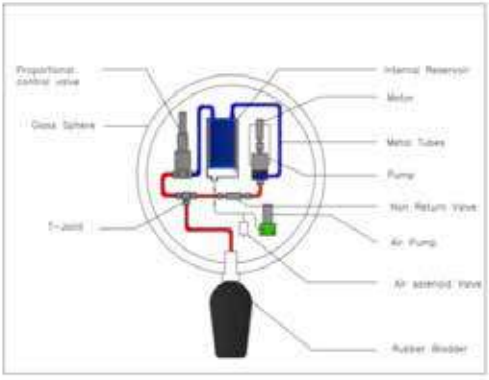
Ocean Electronics group functions with an objective towards the development of new ocean observation technologies and systems to improve Ocean data collection, Ocean monitoring and also to address the requirement of satellite communication systems for ocean observation platforms. This group has been concentrating on developments under three major areas such as Development of New Ocean Observation Technologies, the Indigenization of Marine Instruments and satellite communication payload Indian satellites to support Ocean Observation applications. The group has carried out and applied for a significant quantum of patents, publications and effectively executed the technology transfer and licensing agreement with 7 Indian industries including L&T Defense. The group is constantly working on the establishment of an Incubation facility at NIOT to promote the development of marine technologies.

Background

Currently, the group is involved in the development of Deep sea Autonomous Underwater Profiling Drifter (D-AUPD), Sea Glider, Drone based Ocean Data collections and vertical measurements, Open sea fish cage culture technologies, Development of Thermal engine using phase changing material (PCM), material characteristics for powering ocean profilers, Mass production of INSAT based Drifting buoys, Ship based C Profiling system, Development of non-contact type CTD sensor and also Geostationary/Polar satellite payloads for Ocean observation systems with the support of ISRO.

Deep Sea Autonomous Underwater Profiling Drifter (D-AUPD)

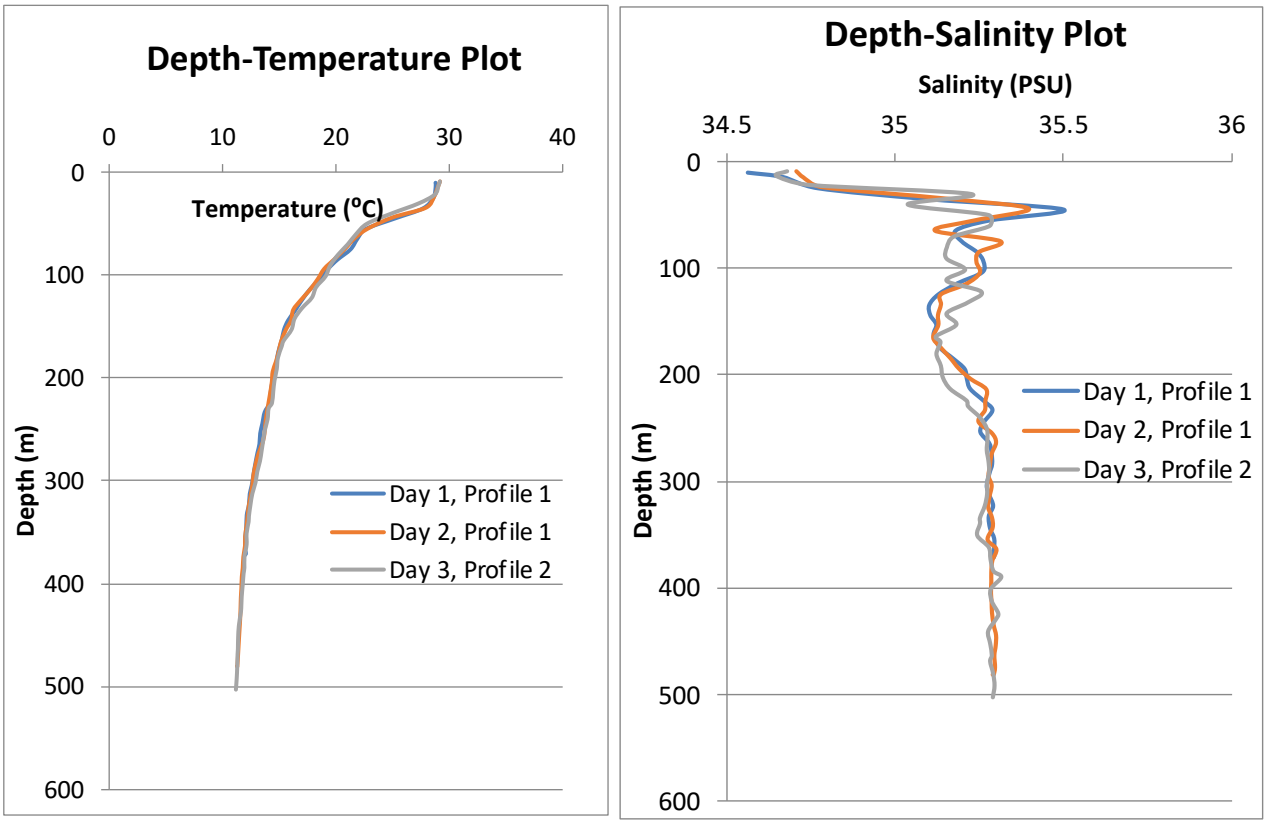
500m depth operable Deep Sea Autonomous Underwater Profiling Drifter (DAUPD) is being developed in-house using a 1000cc variable buoyancy engine which suits operations in Bay of Bengal. The proto-model was tested for basic functional cycling test and a few trials were carried out by deploying the unit up to the depth of 130m operation at the Underwater acoustic research facility (UARF) of NPOL in Idukki, Kerala and up to 500m operations in the Bay of Bengal. Pre & Post ballasting and weight trimming of two DAUPD systems have been completed.



D-AUPD – Bay of Bengal deployment & Variable Buoyancy Engine Schematic

The data telemetry RF antenna suitable for deep sea AUPD systems (5000m) is jointly developed with the support of the Indian industry. Float mission cycles were performed with a simulated water column in the hyperbaric chamber and the system functionality was

observed for different sequences of operations. A short deployment of the DAUPD system was conducted in the Bay of Bengal and a few cyclic measurements were collected during the month of October 2022.



The results of the recent field deployment trial of DAUPD system near off Beypore (Arabian Sea) during 13th -17th October 2022 are shown in the plot.

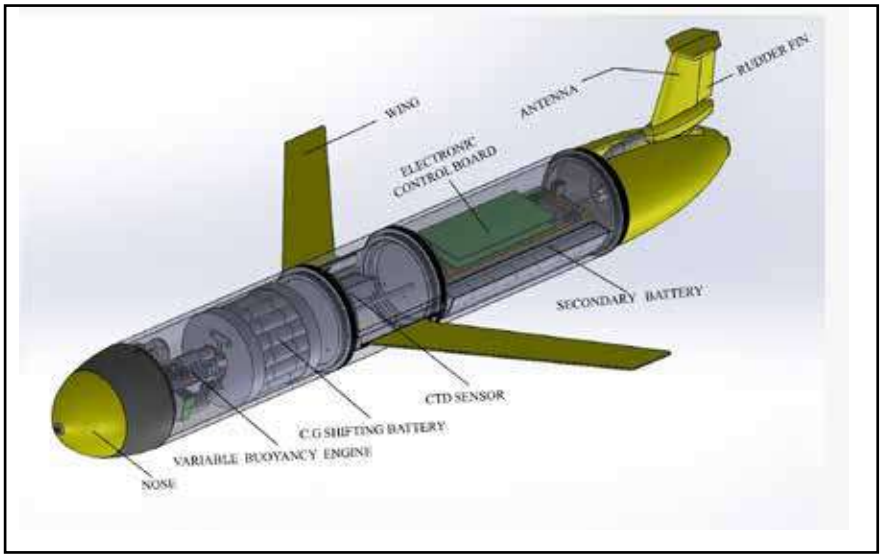
Open Sea Fish Cage Culture Systems and AI based Biomass Estimation Device

The development of a rigid type open sea fish cage culture system has been successfully developed and the functional was demonstrated through permanent deployment at Andaman Islands. Also, a proto model of a 2m diameter spear type open sea cage was fabricated and its working has been demonstrated along with an automatic fish feeder mechanism. This is a suitable method to increase fish farming, especially during adverse weather conditions with minimum human intervention. Detailed engineering design and analysis were carried out for a 12 m dia. sphere type cage using the ANSYS ORCAFLEX design tool.

Internet of things (IoT) based biomass estimation technique is evolved in calculating the growth of fish being nurtured inside the open sea fish cage culture systems. This technique uses an underwater camera and laser pointers mechanism along with Artificial Intelligence based cognitive algorithm to estimate biomass. The proto unit was tested at the CIBA facility in Chennai. The fish images are captured over a period of time and image sizing and quantification are arrived using standard methods. Demonstration and validation of the Bio-Mass estimation device is progressing.

Sea Glider

Deep-sea observation and continuous monitoring are the new frontier for mining, oil exploration, and other industrial activities as they leave the continental shelves for areas miles beneath the ocean surface. To provide high spatio-temporal observation in the deep-sea area, this group is proposed to develop a deep-sea Glider. An indigenization of underwater glider is initiated and procurement and testing of subcomponents are being carried out. Design of variable buoyancy engine operable up to 2000m operations of glider is completed and the fabrication is underway. Design of center of gravity-CG shifting mechanism of the vehicle is completed. Design and modeling of the glider vehicle body using Carbon fibre composite is in the final stage. Variable buoyancy engine operable up to 2000m operations of glider is completed and the fabrication is underway. Design of center of gravity-CG shifting mechanism of vehicle is completed. Design and modeling of glider vehicle body using Carbon fibre composite is in final stage.



Pictorial view of Glider with parts indicated

Thermal Engine

A temperature gradient of around 20°C is abundantly observed in the ocean environment (the Ocean's surface temperature 25°C and that at 1000 m depths is 10°C). Energy can be harvested from these environmental temperature variations using Phase Change Materials. A suitable Phase Change material that can melt in the temperature range (of 5°C to 25°C) when exposed to this cyclic temperature variation undergoes volumetric expansion/contraction that can be used to generate hydraulic power, which can be converted into electricity. It is proposed to study harvesting of thermal energy from the cyclic temperature variation observed by an oceanographic vertical profiling float/ Autonomous Underwater Vehicle/ Autonomous Underwater Glider etc., as it moves along ocean depth. A constant mass vehicle's buoyancy can be changed enough by the volume change to allow it to ascend and descend. PCM is in a liquid state in the upper layers due to warmer temperatures, in a solid state in the lower layers due to colder temperatures, and in a semi-solid state between the two layers. Based on the vertical temperature profile of the Indian Seas, hexadecane has been selected. Volume expansion of the PCM was reported by the manufacturer as about 12.5%, and during the experiment, the volume expansion of the PCM is observed to be 11.2%. The application

PCMs for harvesting energy using its volume expansion/contraction requires displacement of pressurized working fluid to generate work under the effect of cyclic temperate load from the heat source and sink. Therefore, low heat of fusion and high-volume expansion/ contraction are the desired properties. The volume expansion of PCM under the influence of cyclic temperature/ heat flux variation is the driving force for the working/ hydraulic fluid. As the PCM expands, it forces the hydraulic fluid inside a pre-charged accumulator, which is used to store the energy that can be used at a later stage.

The laboratory workable model of a thermal engine is developed and the characteristics of PCM material and its response at different temperature gradient are being studied.

C-Profiler

The C – profiler is designed using a fish that carries conductivity, temperature and depth (CTD) sensors as a payload collecting shallow water data which is vital for ocean predictions. The advantages of this profiler system include the possibility of real-time onboard data retrieval while the vessel is on the move without lifting the probe to the deck and swift changes of sensor payloads on the profiler head. Few field demonstrations have been performed and qualification of the C-Profiler system with user agencies participation shall be carried out.

Indigenization of CTD sensor

Group has initiated a joint development project with IIT Madras in the year 2019 for the development of a non-contact type of capacitive coupled conductivity system. A proto model was developed using a set of contact and electrically insulated non-contact probes to obtain a combined advantage of both techniques. It was tested for a lower and higher value of conductivity of sea water. Auto balancing signal conditioning circuitry is implemented to nullify the effect of capacitive reactance while measuring the resistance of the water column which is proportional to the change in the conductivity of the fluid.

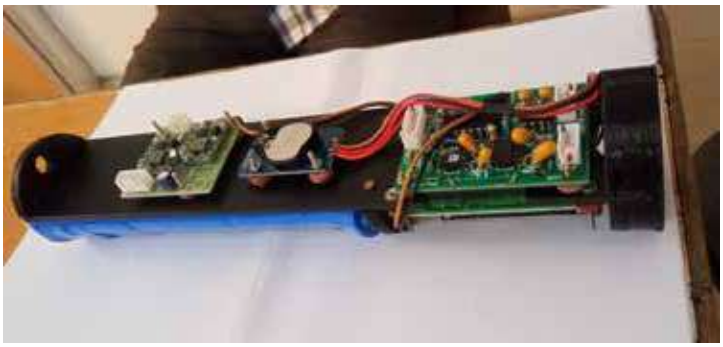


Image of Trial produced CTD sensor and Electronics

On successful development and completion of laboratory model and trials, the trial production of CTD sensor has been taken up with local industry to produce 4 Nos of 1000m operable units. Design and fabrication of different sub components including the pressure enclosure rated for 1000 m operation are completed. Qualification and water ingress tests of CTD sensor enclosure were carried out at the hyperbaric test facility of NIOT. A pressure test of the sensor enclosure was carried out up to 118 Bar. Data acquisition, data sampling firmware and user interface and parameter setting software work is progressing.

Adapting Drone Technology for Ocean Data Collection Applications

Drone - Unmanned aerial vehicles (UAVs) have gained significance across the world for a wide range of commercial and terrestrial defense applications in recent years. NIOT is exploring a UAV with focus on maritime applications. Ocean Electronics group of NIOT has customized a heavy lift category drone operable in marine environments withstanding coastal wind conditions. It can carry any instrumentation payload weighing nearly 10 kg and do any sort of ocean data collection and even seawater samplings. The 10kg payload of the UAV might hold a Conductivity Temperature Depth (CTD) sensor, a programmable automatic sea water sampler and a multi-parameter sensor for ocean data collections, and a Light Detection and Ranging (LIDAR) device integrated with a high flip rate camera for coastal mapping applications.

Heavy Lift – Hexacopter Drone capable of lifting 10kg instrumentation payload

The customized hexa-copter-shaped UAV is capable of withstanding winds of up to 10 m/s and features a waterproof IPX7 thruster with a maximum thrust of 153N per axis. The system also interfaced with Global Positioning System (GPS), barometric pressure sensor, campus, gyroscope, 15MP surveillance camera, and accelerometer sensor connected to a reliable cube orange flight controller module with a redundant 32-bit controller through a serial peripheral interface (SPI). The entire hexa-copter frame is composed of carbon fibre composites to provide an excellent weight-to-strength ratio.

As part of adapting the Drone (Unmanned Aerial Vehicle) technology for marine applications, the group has already demonstrated the functional capability of Drones for various marine applications such as Ocean vertical micro-structure data collection using CTD sensors, automated sea water sampling for Environment Impact Assessment (EIA) Studies and mapping of beach topography and High tide line etc.

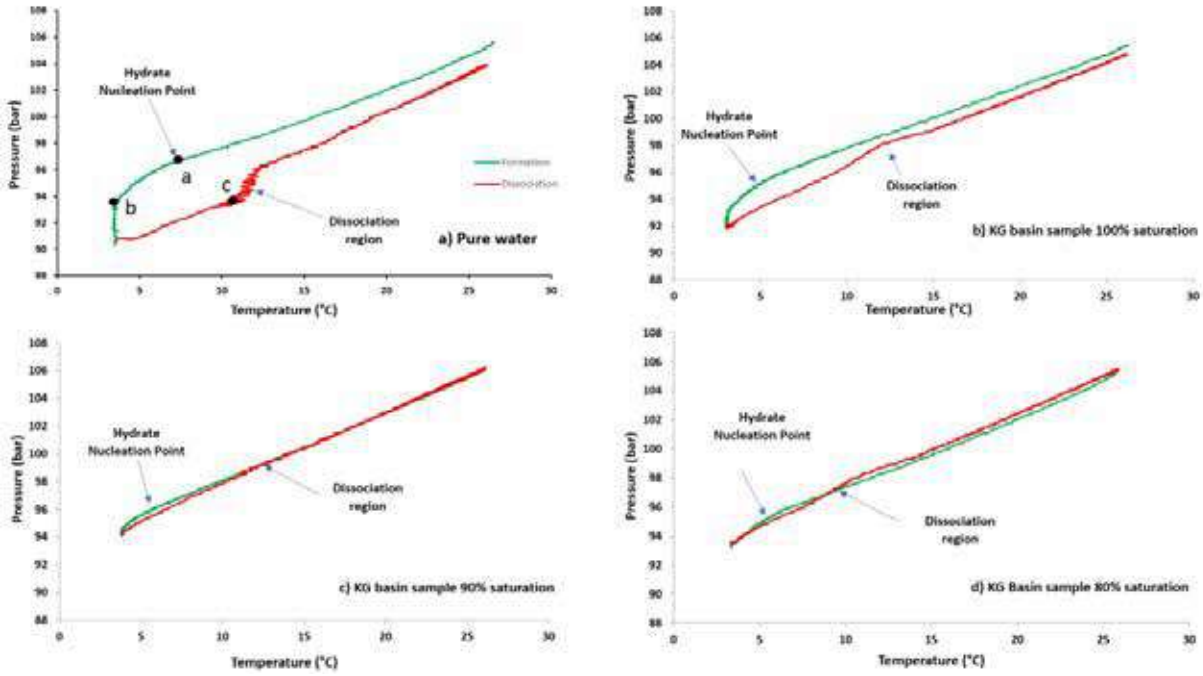
The endurance tests were carried out recently to ensure that the drone flies in time to perform the indented ocean data collection works. The test has been performed using instrumentation payloads of various weights and the lower cut off voltage set is 42V. It ensures a safe fly time of 15 minutes under full payload conditions.

Endurance test carried out with payload
weighing from 5 to 10kg

4.9 TECHNOLOGY FOR GAS HYDRATES

Experimental Studies of Gas Hydrates with KG Basin Sample

NIOT is involved in technology development for gas hydrate which is the non-conventional energy resource occurring in deep sea floor. In order to, understand the formation and dissociation of gas hydrates and to provide inputs for reservoir modelling and field scale dissociation studies, experiments were conducted using the Krishna Godhavari basin sediment to understand better about the kinetics, thermodynamics and behavior of the gas hydrate bearing sediments of Indian reservoir. Methane gas hydrate experiments were conducted with water and KG basin sediment sample of different water saturation levels viz., 100%, 90% and 80%. KG basin field thermodynamic conditions were adopted for this study i.e. 105 bar pressure mimicking 1050m water depth and 3°C temperature. From the results the Hydrate nucleation point, hydrate formation region and dissociation region are identifiable with the pressure and temperature data for Indian reservoir setting.



Experimental results in high pressure low temperature reactor for the gas hydrate formation – dissociation characteristics with Indian reservoir samples

4.10 SEAFRONT FACILITY

The focus of the group is to create a world class Seafront Research Facility (SRF) for creating infrastructure for activities related to development and testing prototype systems, validation of indigenously developed marine systems in the ocean environment and to undertake programs connected with NIOT research / user groups.

Based on the grant in aid, of Rs. 14.74 crores received from Ministry of Earth Sciences (MoES) during March 2007, NIOT has acquired about 153 acres of land to establish Seafront Research Facility in Tirupati District, Andhra Pradesh (A.P) through A.P, State Government at SRF site in Pamanji / Vagarru village and 58.69 acres at Facility for Administrative, Computation and Training (FACT) site in Chittedu Village, Kota Mandal, Nellore, Tirupati District. The final transfer of land took place on July 2021 and NIOT has taken over the entire parcel of the land.

Master plan has been prepared for expansion of NIOT research activities for the next 30 years for SRF and FACT campuses. The master plan has been reviewed and approved by Project Review Coordination Committee during the month of September 2018.

Pre-investment activities

In order to secure the acquired land and to have essential amenities, immediate test facilities were built through CPWD and these facilities were taken over during 2018. Chain link fencing was completed for the Seafront site at Vagarru village.

Test Facilities/ infrastructure

A facility for carrying out Ballast Water Treatment Technology Test Facility (BWTT-TF) is proposed at Seafront site, Pamanji, consisting of Concrete tanks, pumps, pipelines and a laboratory facility for culture standard test organisms. An approach trestle upto 5m water depths into the coast for carrying intake and outfall pipelines and nearshore observations is also proposed. The jetty cum trestle shall accommodate various field operational and deployment requirements of NIOT along with the seawater pipelines for BWTT-TF. Coastal Regulation Zone (CRZ) approval has been obtained from MoEF&CC for establishment of the above facilities.

Establishment of BWTT-TF

The BWTT-TF is proposed to verify the performance of the ballast treatment plants / systems as per International Maritime Organization (IMO) guidelines for ships. The BWTT-TF consists of Reinforced Cement Concrete (RCC) tanks designed in conformance with International Maritime Organization (IMO) guidelines. These tanks are designed to store seawater and carry out the performance tests on Ballast Water Testing Equipment. Structural analysis and detailed engineering design of RCC tanks is carried out inhouse by the Seafront Group of NIOT. Inputs for design of foundations are based on detailed soil investigation carried out by NIOT and vetting of the design is done by Anna University, Chennai.

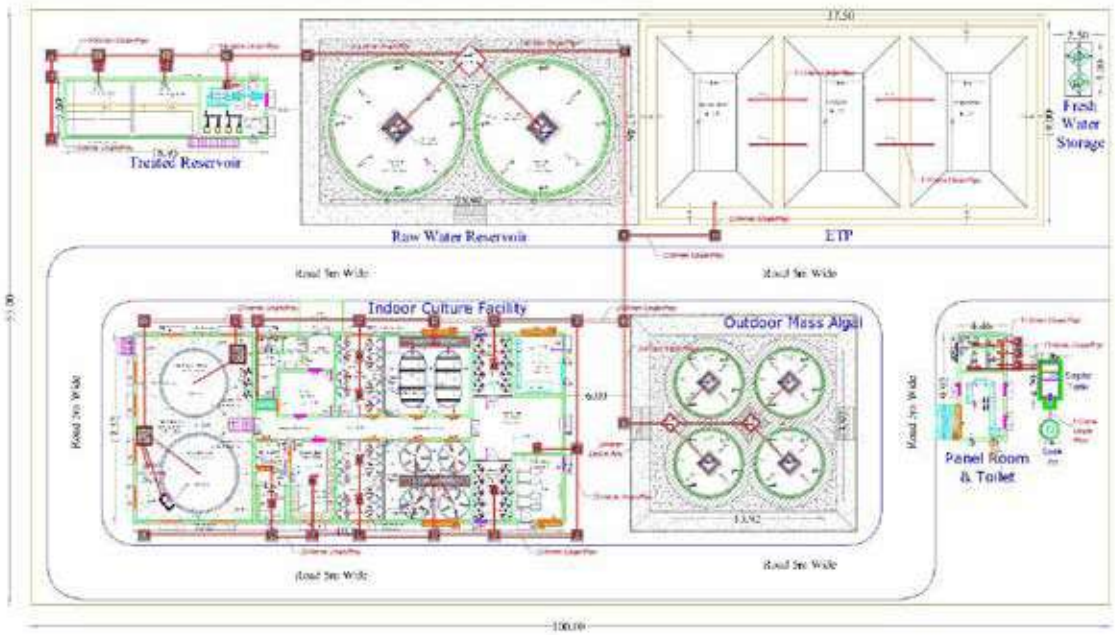
The detailed estimate, rate analysis and estimate was completed for Rs.5.66 crores and the fund has been transferred to CPWD for execution on deposit basis. At present the RCC tanks are under construction which shall be followed by laying of pipelines for conveyance of water.

Fencing works at Seafront

Construction of RCC tanks for BWTT-TF

Establishment of Standard Organism Test Culture Facility (SOTCF)

The SOTCF facility consists of indoor culture facility, outdoor mass algal, treated reservoir, raw water reservoir, Effluent Treatment Plant (ETP) and fresh water storage. The layout, detailed engineering and estimate were completed for Rs.6.66 crores and the fund has been transferred to CPWD for execution on deposit basis. The work order has been issued to the contractor and preliminary works have commenced.

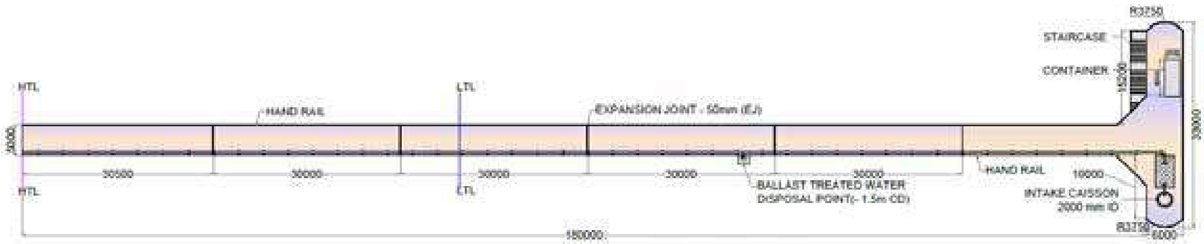


Layout of Indoor culture facility

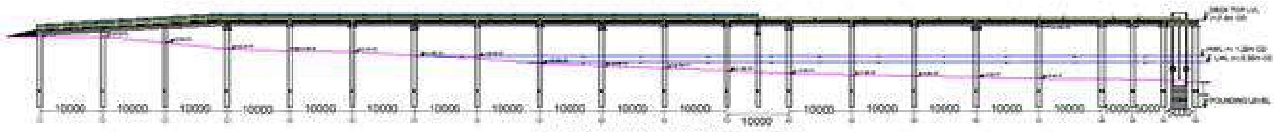
Approach trestle & Seawater intake system

The marine trestle is proposed to support the intake and outfall pipelines for the testing facilities at shore. The seawater intake well is proposed at the end of the trestle.

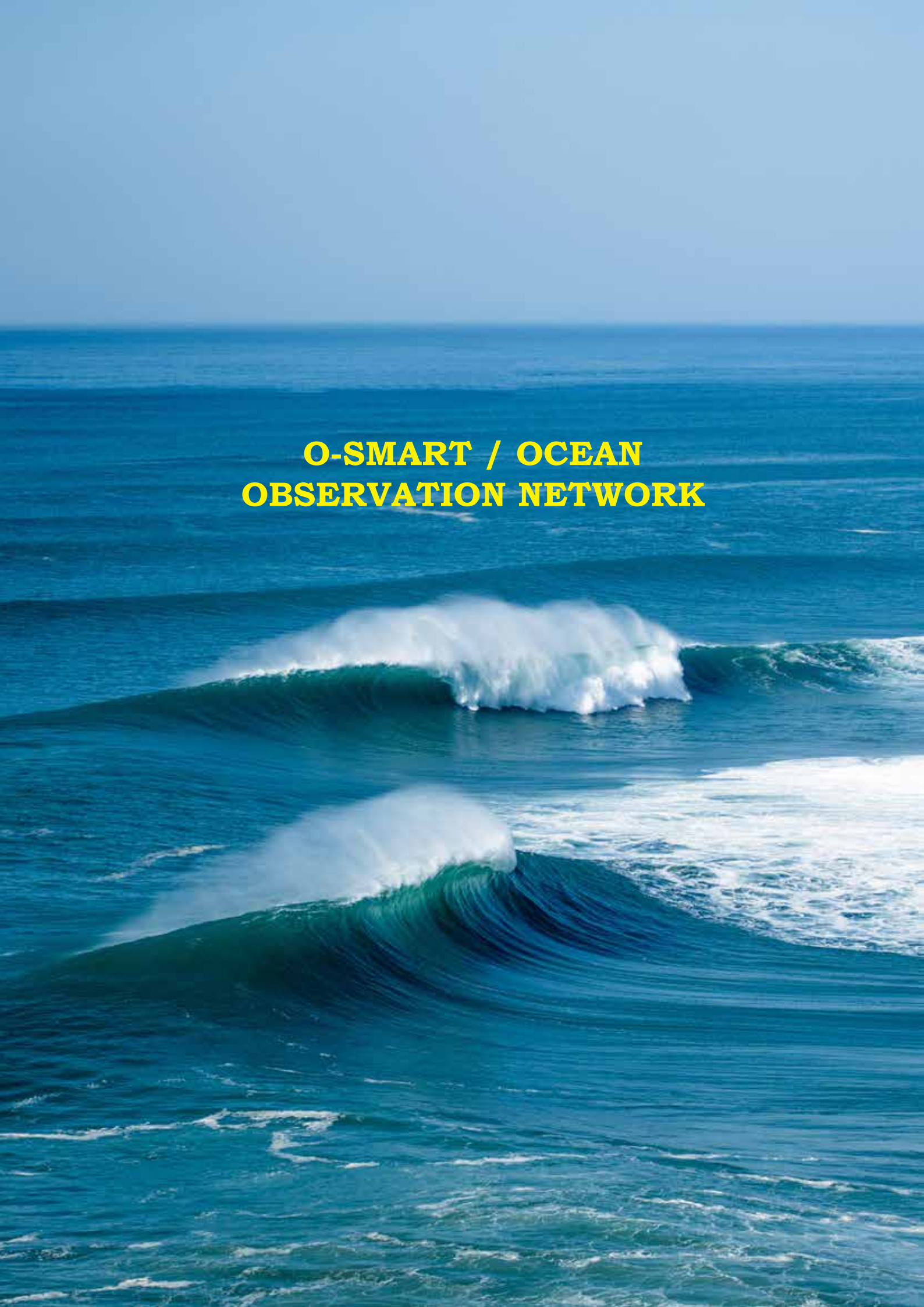
Structural analysis and Detailed Engineering Design of pile supported trestle and jetty has been completed in house and vetting of the design and approval is done by Department of Ocean Engineering, IIT Madras. Detailed estimates, rate analysis and estimation has been completed for Rs.19.12 Cr and placed before CPWD for further action and partial fund has been transferred to CPWD for execution on deposit basis.



OVERALL LAYOUT OF PIPELINE TRESTLE



LONGITUDINAL SECTION DETAILS



O-SMART / OCEAN OBSERVATION NETWORK

5. O-SMART / OCEAN OBSERVATION NETWORK

5.1 OCEAN OBSERVATION SYSTEMS

Primary objectives of this programme is establishment and maintenance of Moored Data Buoy Network, Tsunami Buoy systems in Indian seas as well as real time data collection of met-ocean parameters, dissemination of data in real time to INCOIS and to provide operational support to the International NOAA-PMEL RAMA moored buoy network in Indian seas.

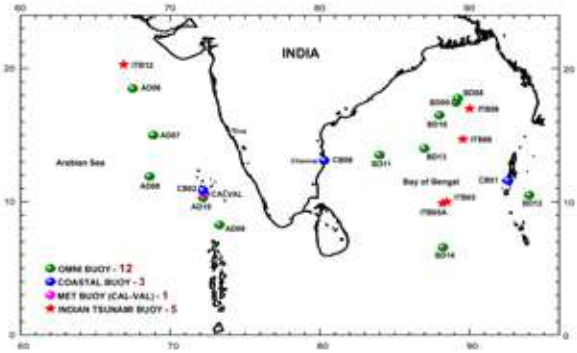
Background

The buoy network during1997-2009 consisted of buoys with met-ocean surface measurements including waves. The existing network of OMNI buoys is augmented with subsurface measurements till 500 m depth and also implemented with high frequency transmission during cyclones in rapid mode. The buoy network is maintained by conducting regular cruises to both the Arabian sea and the Bay of Bengal together with field trips for coastal and CAL-VAL buoy sites. The IndARC mooring near the Arctic poleis being maintained jointly with NCPOR since 2014. The real time data from the Indian Moored buoy network are transmitted through satellites to the shore-station at NIOT, Chennai, and are disseminated to INCOIS in real-time for operational forecast and to issue cyclone/tsunami alerts if any. Public access to Indian moored buoy data is made available through the joint data portal OMNI-RAMA. The data from Automatic Rain Gauge (ARG) installed at NIOT, Chennai is being shared with IMD's National ARG network and is also uploaded in IMD website.

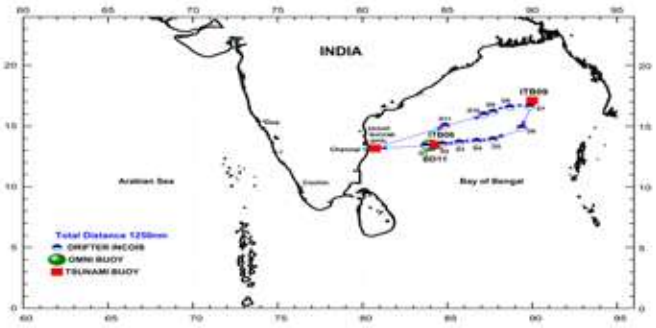
The real time as well as retrieved data quality control is being done following best practice methods. These long-term data are used for research, satellite data validation and ocean modeling applications. An In-house calibration facility is established at NIOT to accelerate the calibration process and to reduce the costs towards re-export to foreign OEMs. Established state-of-the-art data reception centre CORNEA. A software tool ADDRESS is developed in-house for the storage, archiving and visualization of the huge data sets in micro and macro levels for ease of management. NIOT moored buoys captured the signals of many cyclones that passed in the vicinity of the buoys since 1997 and provided significant information for issuing cyclone early warning especially after implementing the high frequency rapid mode algorithm in the buoys. As part of Indigenous technology development, six technologies were successfully transferred to three industries. Many papers are being published in peer reviewed journals every year.

(i) **Indian Moored Buoy Network:** OOS team has sustained the moored buoy network over the past two and half decades. The present buoy network comprises of twelve (12) OMNI buoys with profile measurements up to 500m in deepwaters, three (3) coastal buoy systems, one (1) CAL-VAL buoy system for SAC/ISRO, and four (4) Tsunami buoy systems and one (1) IndARC mooring at Kongsfjorden, Norway.

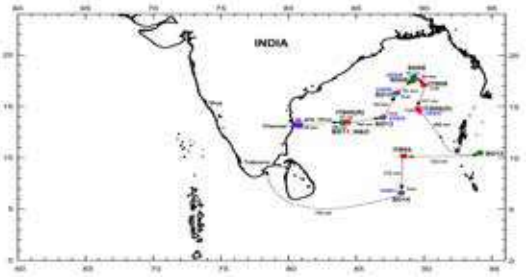
(ii) **Regular Buoy Maintenance Cruises :** OOS team has successfully carried out two Bay of Bengal cruises during 02-18 September 2022&22 January to 18 February 2023 onboard ORV Sagar Nidhi respectively, and successfully completed 24 buoy operations (6 buoy retrievals, 5 mooring retrievals & 13 deployments) in 45 ship days, covering 3910 nm. Bathymetry surveys and CTD castings are also carried out at each buoy locationand deployed 5 drifter buoys in BoB. During the reporting period, the Arabian Sea cruise could not be carried out due to shortage of ship time.



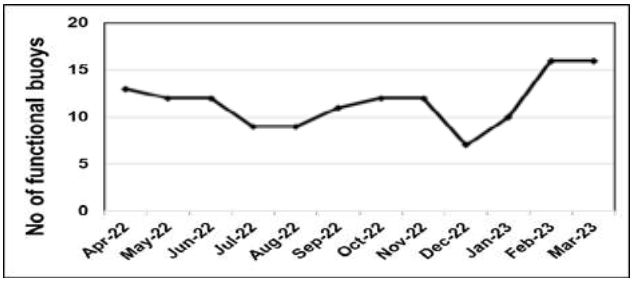
Moored Buoy Network in NIO



BoB Cruise Tracks -September 2022



BoB Cruise Tracks -January 2023



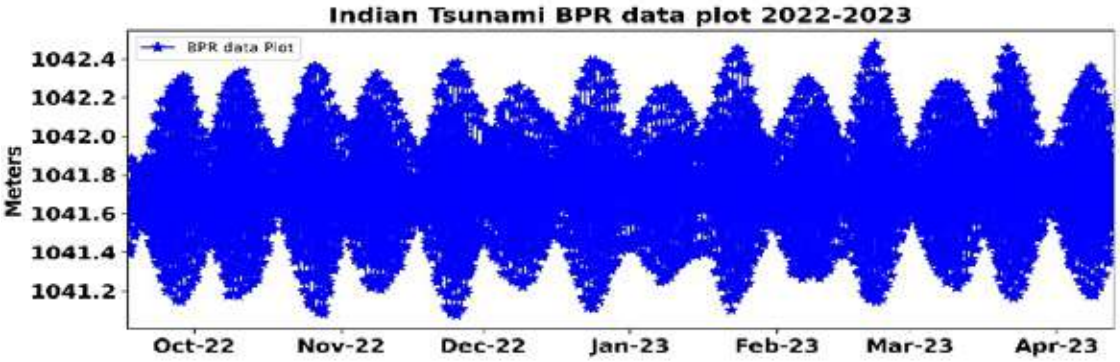
Functional Buoy Status-
Apr 2022-Mar 2023

The drifting buoy system BD11 in the BoB were retrieved twice by ICG during May 2022 and Dec 2022 by OOS team sailing on ICG vessel. Coastal Buoy System (CB06) was successfully recovered near Marina Beach, Chennai during November 2022. BD12 in Andaman sea was retrieved by ICG during July and November 2022 from Port Blair and OOS team received the same from CG. The drifted BD10 OMNI buoy was recovered using Sagar Anveshika during January 2023.A beached RAMA buoy (15N, 89E) was retrieved from a Coastal Village in Poombhuhar, Tamil Nadu in January 2023.

Retrieval of drifted and beached buoys

(iii) **Technology Developments - Development of Indigenous BuoyComponents:** A Prototype unit of Indigenously developed Tsunami Bottom Pressure Recorder (BPR) Sagar Bhoomi was successfully deployed off Chennai on 17th September 2022, which worked satisfactorily for over a period of seven months and the data plot depicts the performance.

Indigenously developed Tsunami BPR Sagar Bhoomioff Chennai &
Subsurface Tsunami Buoy with underwater winch system testing at ATF



Performance of Indian Tsunami BPR Sagar Bhoomioff Chennai

Subsurface Tsunami Buoy System : A laboratory scale prototype subsurface Tsunami Buoy System was successfully demonstrated at acoustic test facility at NIOT. The design and development of an underwater winch system for subsurface tsunami buoy system was carried out. The underwater enclosure was designed for 300 m rating and the underwater performance was evaluated at ATF and was found satisfactory. For long term operation at location, the winch system will be positioned at 300 m water level and will be assembled with the subsurface tsunami buoy system.

Upgradation of Tsunami BPR Units : OOS team successfully deployed a new generation 6G Tsunami BPR units at 3 locations (TB09, TB06 &TB05) in the BoB, that are capable of providing operational life of two years at the site in order to reduce the maintenance cycle.

Iridium Satellite Telemetry : Iridium satellite telemetry was successfully interfaced & installed with NIOT Moored Data Buoy system and deployed in BD10 location in BoB on 30th Jan 2023. This will reduce the latency and cost of data communication.

Indigenous Static Pressure Head Inlet for buoy air pressure sensor installed in order to improve the measurement accuracy even when the buoy motions are more during rough weather conditions.

Indigenously developed 500m induction cable for buoy mooring was successfully deployed in BD09 deep sea buoy mooring system on 31st Jan 2023 and the performance is found to be satisfactory.

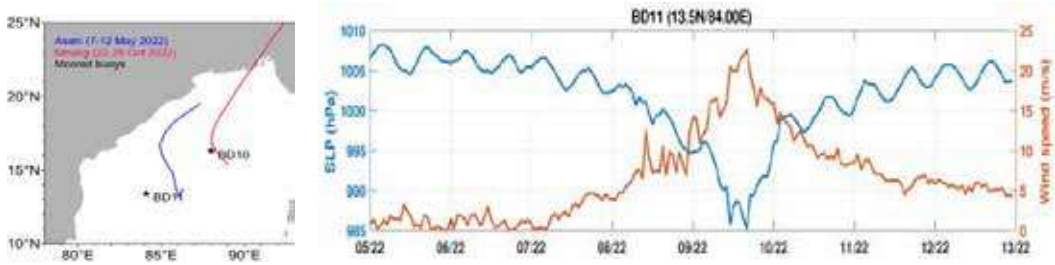
Establishment of Tsunameter test rig for validation of Tsunameters in laboratory environment. The facility was inaugurated by the Director NIOT on 24th March 2023.

Interfacing satellite telemetry at Himash by OOS team and Inauguration of Tsunameter test rig at NIOT.

OOS scientists successfully interfaced Inmarsat satellite telemetry at Indian Himalayan research station-Himansh for Real time AWS data transmission during 27th August to 4th September 2022.

(iv) Buoy data utilisation

Significant Observations during Cyclones: NIOT moored buoys captured the signals of two cyclones – Severe Cyclonic Storm Asani (May 2022) and Cyclonic Storm Sitrang (October 2022) in the north Indian Ocean and provided real-time observations. During Asani, the Sea Level Pressure dropped to 986.5 hPa. The peak wind speed and gust recorded were 21.7 m/s and 38.75 m/s respectively, while maximum wave height observed was 11.1 m at BD11 (84.00°E/13.5°N) location on 9th May 2022.



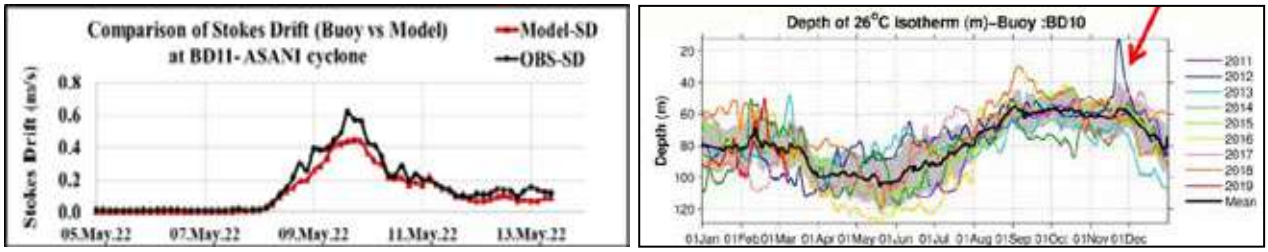
Tracks of Asani & Sitrang cyclones along with moored buoys in the Bay of Bengal & Significant observations from BD11 during Severe Cyclonic Storm Asani

Seasonal temperature variability observed at abyssal depths in the Arabian Sea: The inter-annual variability in sea bed temperature at OceanSITES buoy in the Arabian Sea, was observed and the probable reasons were explored. The study revealed the dominant role of deep meridional overturning circulation influenced by monsoon wind forcing on the observed temperature variability near-the seafloor. These results were published in Nature Scientific Reports.

Depth Remapping in OMNI Buoy Measurements: The possibility of depth variability in subsurface measurements due to the stretching of the single point Inverse catenary mooring of NIOT OMNI buoy under extreme weather events is analyzed using additional depth measurements at 10m, 50m, 100m and 200m, apart from the standard 500m depth. It is found that, the actual depth variability and the corresponding temperature variations are much less (order of 0.01oC), for depths shallower than 75 m. Based on this study, an additional depth measurement at 100m is recommended in OMNI buoys.

Observations of Cyclone-Driven Intensification of Mesoscale Eddy in the Bay of Bengal: The sharp drop in SSHA revealing the intensification of the pre-existing eddy during the passage of the Tropical Storm during November 2012 is analyzed using data from a suite of satellites and BD10 observations.

In-house Data Products: The development of the oceanographic tool for naval application utilizing moored buoy observations is initiated. High frequency time series observations of more than two decade are being utilized to develop location specific variability and climatology. Data products on Stokes Drift and Wave Energy from long term OMNI-Wave buoy data have been prepared.



Comparison of SD(Buoy vs ERA5) during cyclone ASANI &Depth of 26 °C isotherm (D26) from BD10

Wave Spectral Characteristics in the North Central Bay of Bengal: Deepwater wave spectral characteristics at northern BoB are studied using wave measurements during 2012-2018.The monthly averaged wave spectra (Jan, May, Oct-Dec) show a large variation due to extreme events in the BoB. In addition, the spectral characteristics during Cyclone Phailin are also being investigated.

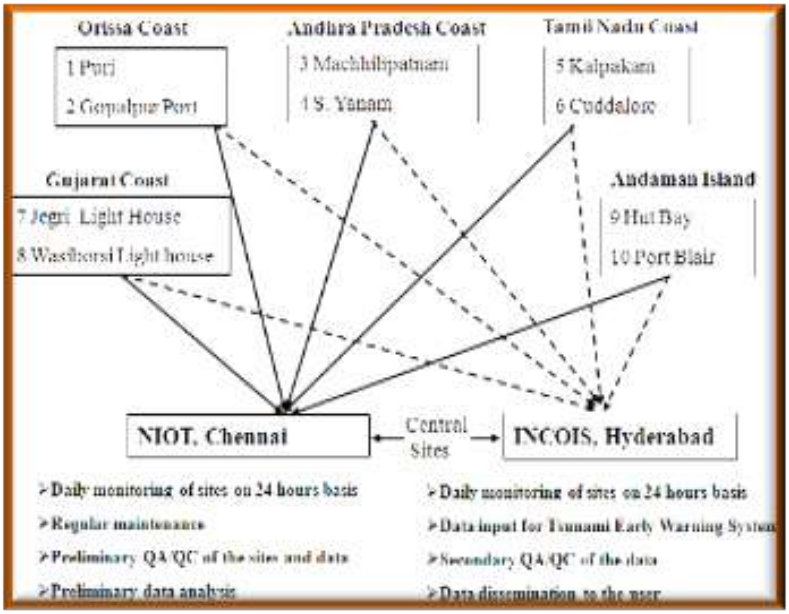
Intense upwelling in the SE Arabian Sea during the post-monsoon season: The upwelling observed in the SE Arabian Sea during the post-monsoon season and its inter-annual variability is explored utilizing the moored buoy data of AD09 &AD10.At AD10 location, the up-welling starts in March and peaks in October with more pronounced shoaling than at AD09 as it is closer to the coast.

Buoy Performance During Cyclones (2011-2021) : The performance of 12 OMNI buoys during the passage of cyclones over 11 years (2011-2021) have been analyzed considering the track distance, intensity, availability and functionality of the buoy, during cyclones. In general, the Arabian Sea buoys recorded higher performance with 100% performance of AD07 buoy in central Arabian Sea.

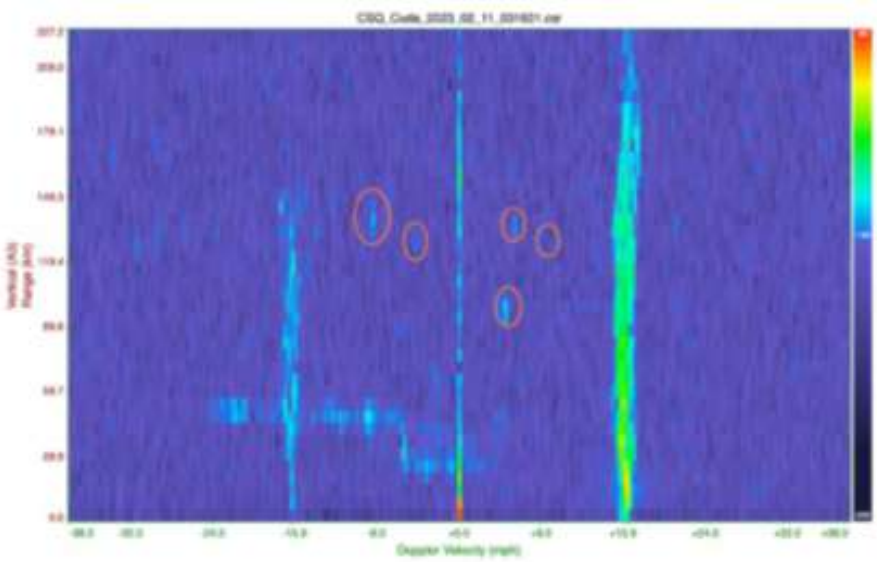
5.2 HF RADAR - OPERATIONS AND MAINTENANCE OF INDIAN COASTAL OCEAN RADAR NETWORK (ICORN)

The mandate of ICORN is to operate and maintain (5 pairs) HF Radar (10 HF Radar) systems along the Indian coast. This project is under Ocean Observation Network (OON) Program of MoES. The data from 10 remote sites are transferred simultaneously to central servers at NIOT, Chennai as well as INCOIS, Hyderabad. The data is disseminated to various research organizations and academia through INCOIS.

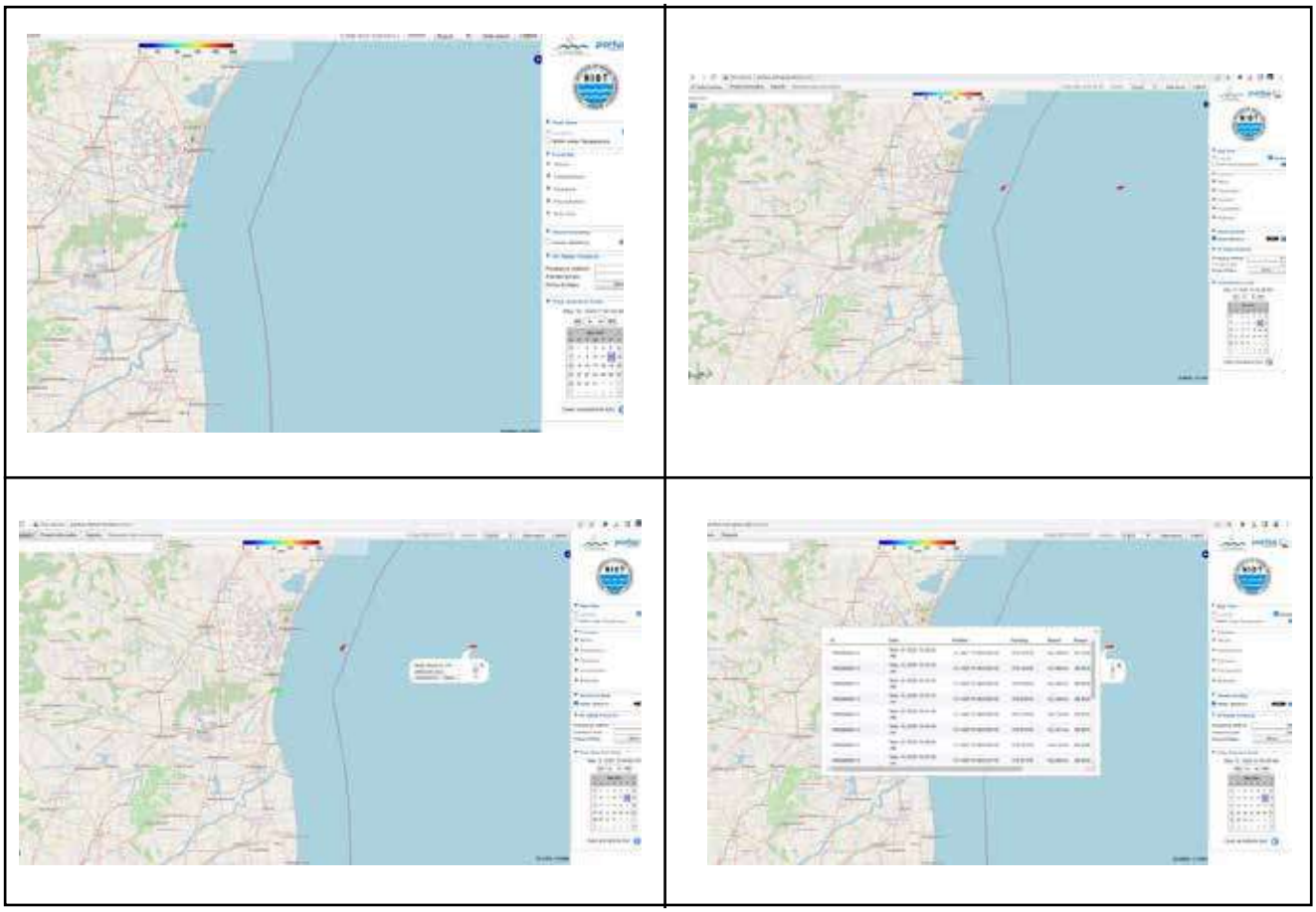
- Seven sites are working along Indian coastline and Andaman & Nicobar Island. The AMC of allied services for all HF Radar remote sites has been established successfully.
- The vessel tracking module has been installed at Cuddalore HF Radar site for detecting vessels as part of the HF Radar application. The first sea trial was carried out during the month of September 2022.
- Observed cross spectra with Potential Vessels circled in orange at the Cuddalore site is provided below.



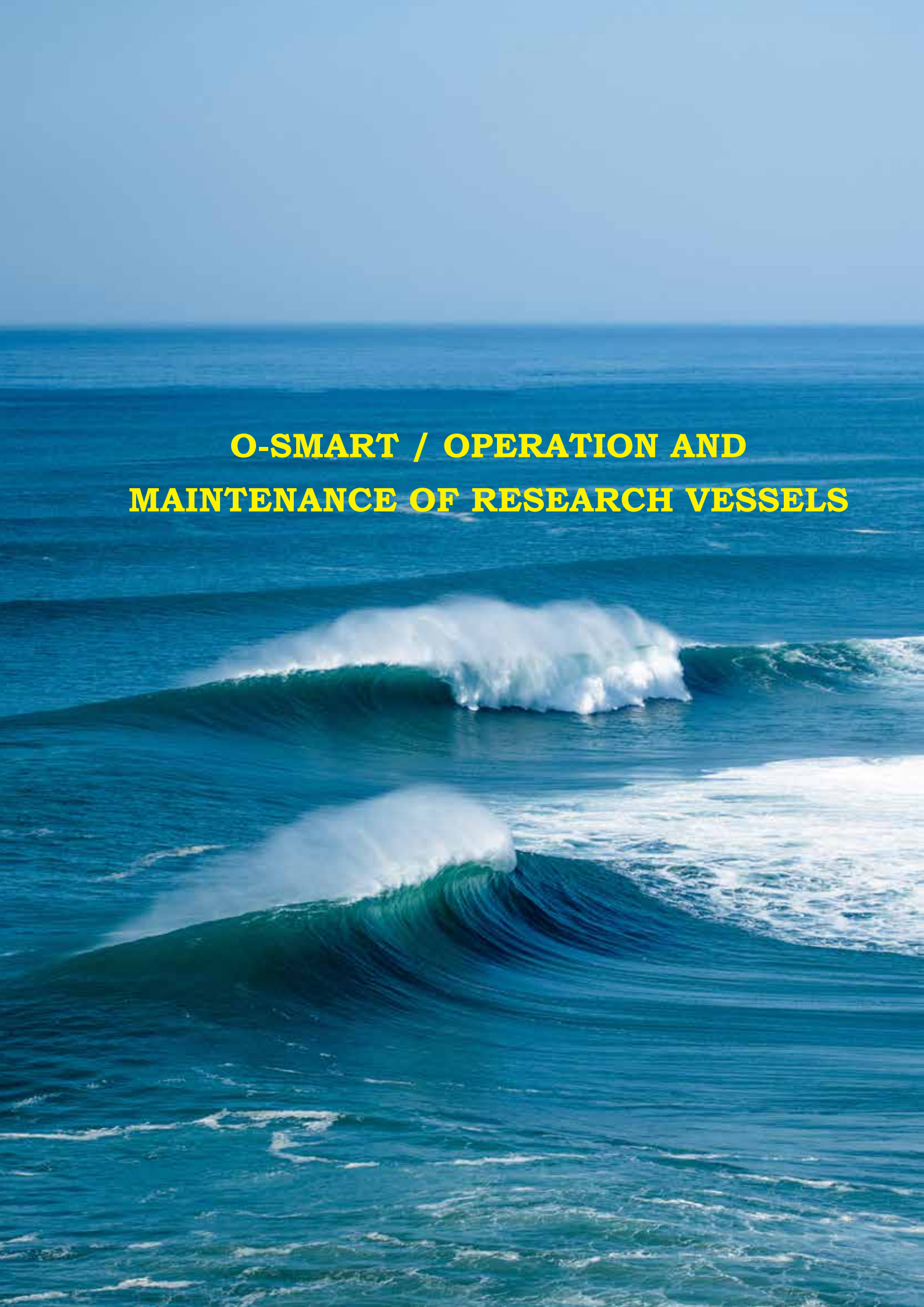
HF Radar locations



Vessel detection from the HF Radar cross spectra



Vessel detection using Portus software



O-SMART / OPERATION AND MAINTENANCE OF RESEARCH VESSELS

6. O-SMART / OPERATION AND MAINTENANCE OF RESEARCH VESSELS

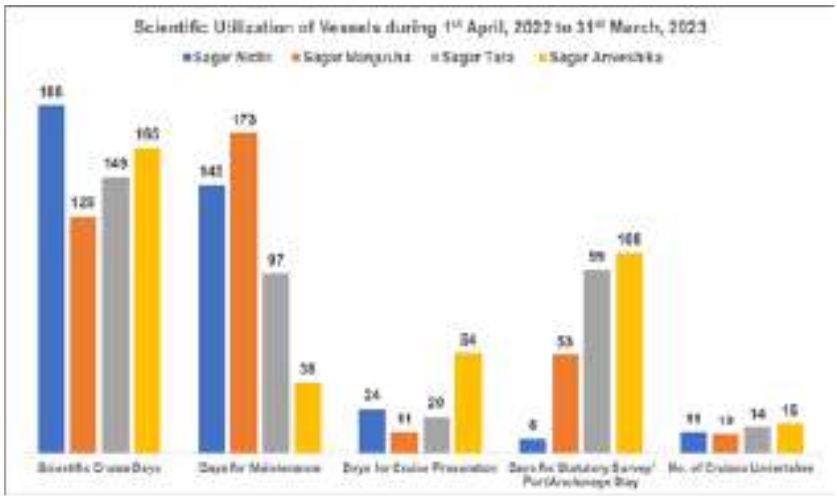
6.1 VESSEL MANAGEMENT CELL

Research Ships of NIOT/MoES [Sagar Nidhi, Sagar Manjusha, Sagar Tara & Sagar Anveshika] are versatile ocean observing platforms equipped with advanced scientific equipment and mechanical handling equipment for technology demonstration and oceanic observations, which are on par with International Standards. It is important to suitably prepare ships for numerous scientific activities keeping safety as the utmost priority. VMC teams is responsible for the operations and technical management of the NIOT fleet of Research Ships and help to facilitate the Scientists onboard to carry out the research which are interdisciplinary in nature. Constant efforts and regular follow up by the team on various technical/operational issue results in operating the research ships as per the approved cruise schedule recommended by JSTAC.

In addition, persistent approach is put up to develop and implement low-cost innovative engineering and green technology solutions for various technical issues that occur onboard ships. These engineering solutions have increased the reliability, safety and technological performance of shipboard system and has enhanced the operational time by minimizing down time hence benefitting the scientific community to a great extent.

Scientific Utilization of Vessels during 1stApril 2022 to 31st March 2023

Ship	Scientific Cruise Days	Days for Maintenance	Days for Cruise Preparation	Days for Statutory Survey/Port/ Anchorage Stay	No. of Cruises Undertaken
Sagar Nidhi	188	145 [Dry-dock & Afloat Repairs at CSL]	24	8 [Statutory Survey]	11
Sagar Manjusha	128	173 [Dry-dock & Afloat Repairs at CSL]	11	53 [Bad Weather/Statutory Survey Cyclonic Warning]	10
Sagar Tara	149	97 [Dry-dock & Afloat Repairs at CLSPL]	20	99 [Bad Weather/Transfer of Ship Management/Cyclonic Warning/Lay-Up as per DG Shipping Guidelines/Preparatory activities for dry-dock/Statutory Survey]	14
Sagar Anveshika	165	38	54 [Installation & Testing of Ship Tracking System]	108 [Annual Survey/Adverse weather/ Transfer of Ship Management/Cyclonic Warning/Statutory Survey by Class/Flag, Hot Lay-up	16



Major cruises/significant work undertaken onboard NIOT Fleet:

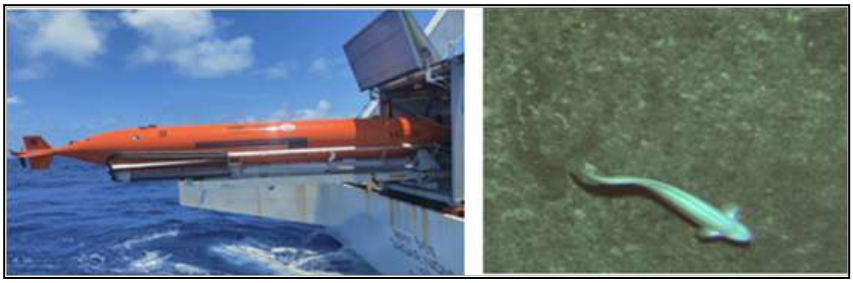
- Successful completion of Buoy Deployment, Retrieval and Maintenance in Bay of Bengal and Indian Ocean – 19 successful deployments by OOS-NIOT for MOON Project onboard Sagar Nidhi.

Deployment and retrieval of operational buoys for insitu observation

- Successful completion of Fiber Optic Intrusion Detection System (FOIDS) trials in Bay of Bengal by NIOT/NPOL - DRDO team onboard Sagar Nidhi.

Fiber Optic Intrusion Detection System (FOIDS) trials onboard Sagar Nidhi

- Sea Acceptance & Exploration trials of Autonomous Underwater Vehicle (AUV)-Ocean Mineral Explorer (OMe-6000) in Polymetallic Manganese Nodule field at Central Indian Ocean by DST-NIOT onboard Sagar Nidhi.



AUV trials onboard Sagar Nidhi

- EFW-NIOT for deployment of a surface buoy with a novel mooring configuration with sub-sea sensors upto 1000m water depth for the first time for long term in-situ measurements of current and temperature profiles off-Lakshadweep Islands in Arabian Sea onboard Sagar Nidhi.

Deployment of Surface buoy off-Lakshadweep Islands using Sagar Nidhi

- INCOIS for deployment of deep-sea gliders into Bay of Bengal to study climate change under Deep Ocean Mission onboard Sagar Manjusha.

Deployment of Deep-Sea Gliders using Sagar Manjusha

- OE-NIOT cruise for DAUPD Deployment and Retrieval in Arabian Sea onboard Sagar Manjusha.

DAUPD trials onboard Sagar Manjusha

- Deployment of automated sensor-based coastal water quality buoy off-Vizag coast for real-time monitoring of parameters by NCCR onboard Sagar Tara.
- Reconnaissance Survey cruise off Tamil Nadu coast for Tamil Nadu Govt/IMU, ISRO-SAC for Development of Algorithm for Carbon and Nitrogen Components onboard Sagar Tara.

Collection of water / sediment samples in situ analysis onboard Sagar Tara

- Sagar Tara successfully completed scientific cruise undertaken by OE-NIOT for Deep Sea Autonomous Underwater Profiling Drifter (DAUPD) sea trial.

Deployment of Float using J-Frame and resurface [OE-NIOT]

- Sagar Anveshika successfully completed scientific cruises undertaken by NCCR for Sea Water Quality Monitoring Programme in the Bay of Bengal & Arabian Sea.

Collection of water and sediment samples [NCCR Cruise]

All Ships under NIOT are undertaking scientific/technology demonstration cruises as per JSTAC approved cruise schedule.

Dry-dock & Afloat Repairs of Sagar Nidhi and Sagar Manjusha:

- As per the guidelines of Statutory Authority, Dry dock and Afloat Repair of Sagar Nidhi and Sagar Manjusha was successfully completed at M/s Cochin Shipyard Limited on 19th August and 12th September 2022 respectively. All statutory surveys/mandatory audits were completed.

- Both the ships are performing satisfactorily and presently undertaking scientific/ technology demonstration cruises as per JSTAC schedule.

Dry dock and afloat repair work of Sagar Nidhi at Cochin Shipyard Ltd.

Dry dock and afloat repair work of Sagar Manjusha at Cochin Shipyard Ltd.

Sagar Tara:

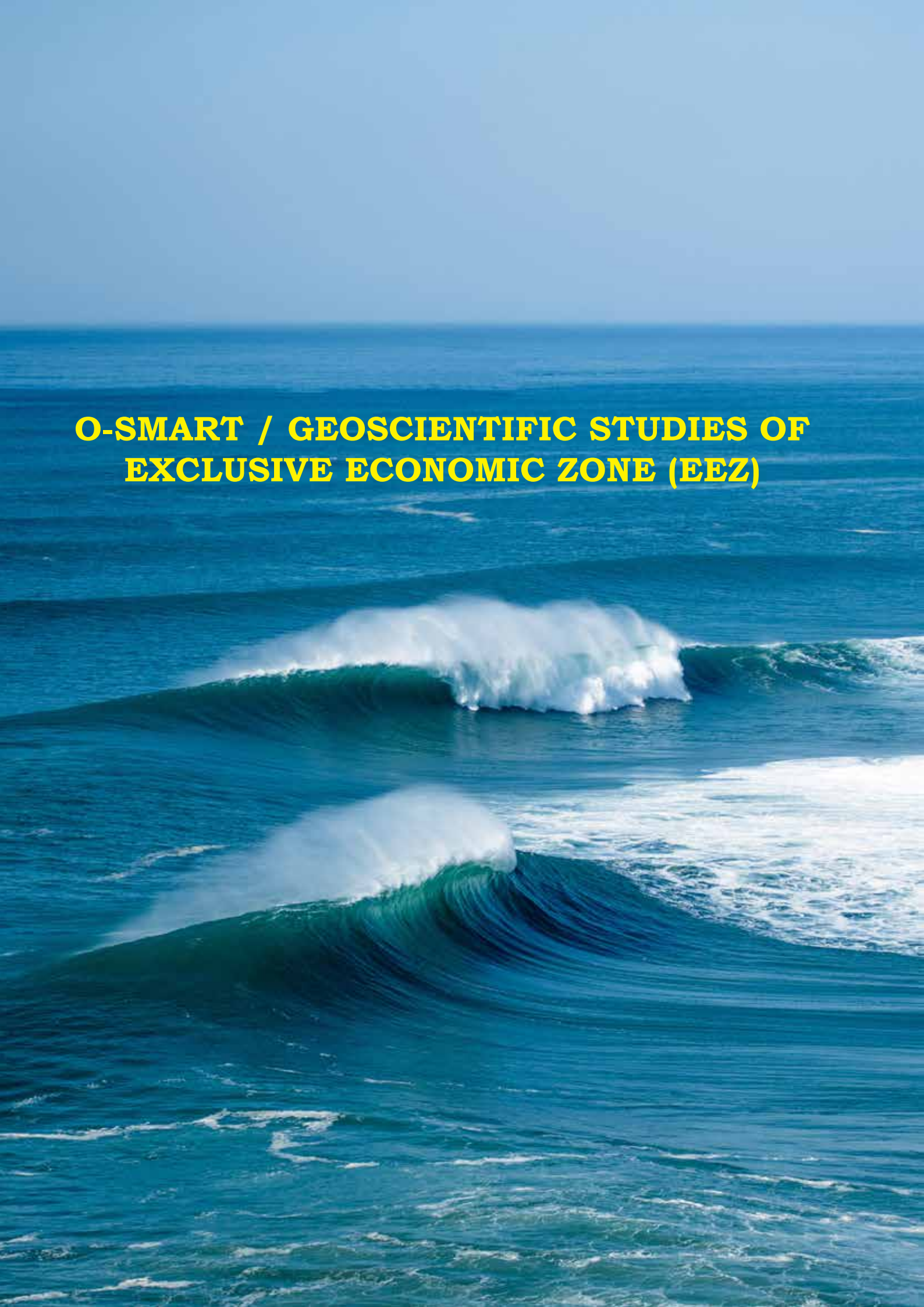
- As per the guidelines of Statutory Authority, Dry dock and Afloat Repair of Sagar Tara was successfully completed at M/s ChowguleLavgan Ship Repair Pvt Ltd. Ratnagiri on 27th August 2022.
- Ship is performing satisfactorily and presently undertaking scientific cruises as per JSTAC schedule.

Dry dock and afloat repair work of Sagar Tara at Lavgan Shipyard, Ratnagiri

Transfer of Ship Management Contract:

- Based on OM received from MoES vide OM dt.31st May 2022 and in-line with the Total Management Contract signed between MoES & M/s ABS Marine Services Pvt. Ltd., dt.31.5.2022, NIOT took necessary action to complete the takeover of the vessels Sagar Tara & Sagar Anveshika on 1st June 2022 after due completion of requisite formalities at Chennai.
- Similarly, based on MoES OM No. MoES/Task Force-VM/05/2017 PC-III dt.3rd August 2022, NIOT took necessary action to complete the takeover of the vessels from SCI viz., Sagar Manjusha & Sagar Nidhi between 11th to 15th July 2022 & 21st-23rd July 2022 respectively after due completion of requisite formalities viz at Cochin Shipyard Ltd., Cochin.

O-SMART / GEOSCIENTIFIC STUDIES OF EXCLUSIVE ECONOMIC ZONE (EEZ)



7. O-SMART / GEOSCIENTIFIC STUDIES OF EXCLUSIVE ECONOMIC ZONE (EEZ)

7.1 EEZ- EAST COAST SHALLOW WATERS - NIOT COMPONENT

Focus of this study is :

- To carry out shallow water bathymetry survey from 0 to 30m water depth using Single-beam Echosounder and Topographic survey from 0m to 2m above HTL along East coast of India (Tamil Nadu, Andhra Pradesh, Odisha and West Bengal).
- To carry out offshore water bathymetry survey from 30 to 500m water depths using Multi-beam Echosounder along East coast of India (Andhra Pradesh, Odisha).

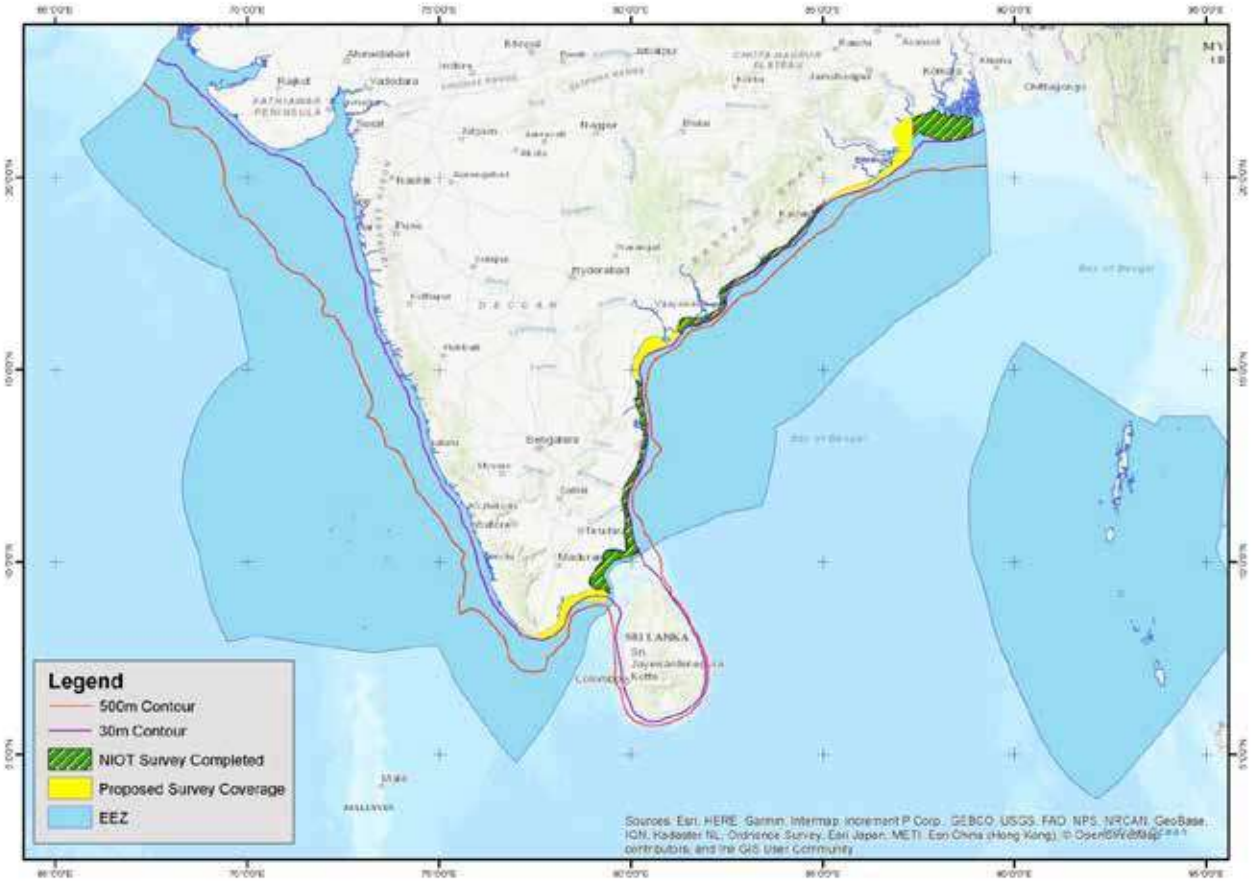
Shallow water bathymetry survey along West Bengal and Andhra Pradesh coast has been completed. Survey work of 49% and 53% has been completed in Tamil Nadu and Odisha coasts respectively. Balance surveys along Tamil Nadu and Odisha coasts shall be completed after monsoon.

Shallow water bathymetry coverage status

Sl No	State	Area (Sq. Km) (0 to 30m)	Length (km)	comp (km)	% (coast Line)
1	Tamil Nadu	18501	910	650	70
2	Andhra Pradesh	11217	974	974	100
3	Odisha	9007	476	250	53
4	West Bengal	10528	158	158	100
	Total	49253	2518	2032	80

Bathymetry coverage during 2022-23

State	Area (km^2)	Survey LKM	No of days	No of vessels
West Bengal	Completed			
Odisha	4774	30843	115	4
Andhra Pradesh	7066	41489	109	4



Coverage of shallow water bathymetry survey along East coast of India

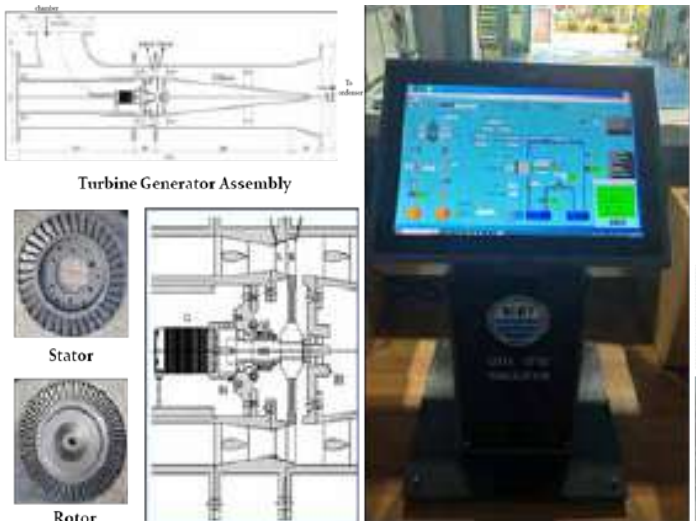
INFRASTRUCTURE

8. INFRASTRUCTURE

8.1 ENERGY AND FRESHWATER LABORATORY

Studies at OTEC-Desalination laboratory in NIOT campus

A laboratory scale OTEC-LTTD demonstration facility situated inside NIOT campus enables carrying out research on open cycle, closed cycle and hybrid cycle of ocean thermal energy conversion systems and low temperature thermal desalination. The setup is equipped with facility to study integrated system also.

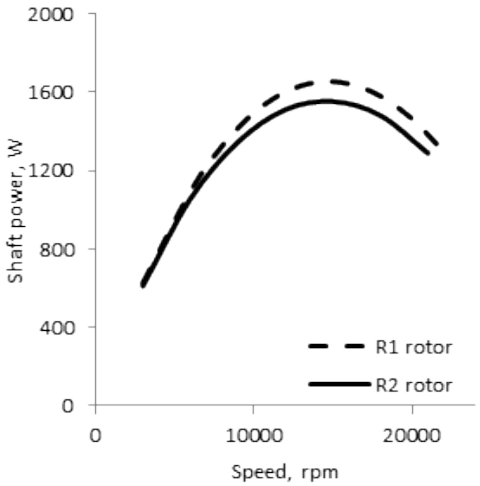


Various components of OTEC-Desalination laboratory setup

The laboratory has a new OTEC-LTTD simulator developed indigenously. This simulator is useful for hands-on experience for the operation of OTEC–LTTD process plant. Additionally, the simulator has Supervisory Control and Data Acquisition (SCADA) system. The SCADA functionality includes high-speed data acquisition system. The plant supervisory control and performance assessment of power module, heat exchanger, done on real time basis. Full automatic control is also under development. Studies on components such as turbine, generator, etc. were carried out for improving design. Performance assessment of open cycle turbines with different bladings were also carried out.

Turbine Parameter	R1	R2
Tip dia of turbine (m)	0.268	0.268
Hub dia of turbine (m)	0.180	0.180
Mean dia of turbine (m)	0.224	0.224
No.of rotor blade	70	50
No. of stator blade	35	35

Laboratory studies on power module with different blading



8.2 HYPERBARIC TEST FACILITY (HTF)

A Hyperbaric Test Facility (HTF) to simulate the high pressure conditions of the deep sea environment, was installed at DST group in NIOT, Chennai. The HTF is a pressure vessel made from high strength alloy steel which is designed to withstand an internal pressure of 900bar. The chamber size is 3m in length and 1m in diameter and can hold components within this size comfortably. The chamber is filled with water and pressurized through special high pressure positive piston pumps.

All the components that are deployed for deep waters up to 6000m MSL are tested and qualified in this chamber prior sea tests / sub-sea applications. The chamber lid is provided with special feed through ports for providing electrical power, Data logging, instrumentation interface etc. This allows testing of the components online at different pressures

HTF Facility

HTF - Test Chamber Details

Ser	Description	Details
1	Test Pressure	600 bar
2	Chamber Size	Dia. 1.0 m, Height 3.0 m
3	Test Temperature	Ambient condition
4	Test Medium	Potable Water with Anti-corrosion additives
5	Test Pressure Rise and Decrease	Auto Mode – 100 bar in 72 s Manual Mode – Can be slower than auto mode
6	Test component limiting size	Dia./Width –0.9 m Height/Length – 2.5 m Attitude of Mounting Inside - Vertical
7	Test component weight	Max. 2000 kg in air
8	Feed through ports for power and online monitoring	UNF ports - 7/16",5/8", 1/2", 3/4", 1", 1-1/2" Flanges - Dia. 30/32/35/56/90.9 mm

Pressure testing of Subsea HPU

Pressure testing of Sub-sea HPU

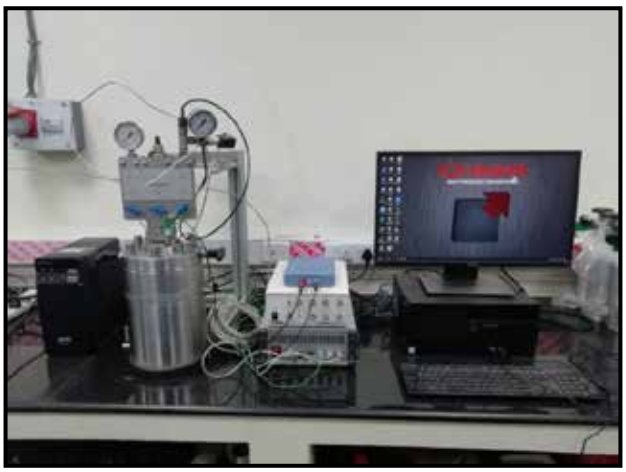
Pressure testing of Subsea Transformer

8.3 LABORATORY FACILITY FOR GAS HYDRATES EXPERIMENTS

In order to understand the formation and dissociation of gas hydrates and to provide inputs for reservoir modelling and field scale dissociation studies, a laboratory is being established at NIOT. The systems has provisions to measure the in situ physical properties such as thermal conductivity and sound velocity during the formation and dissociation of gas hydrate processes

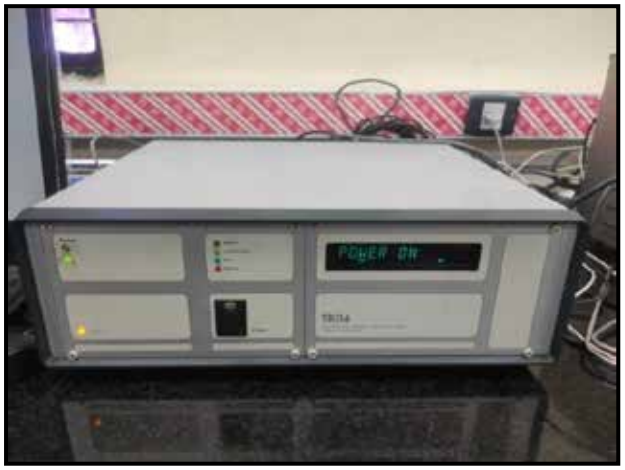
Specifications:

Reactor	High Pressure & Low Temperature
Reactor Capacity	2 L
Working Pressure Range	0 to 250 bar
Temperature Range	-50 °C to +50 °C
Thermal Conductivity Range	0.1 - 10 W/mK
Material	Stainless Steel (SS-316L)
Gas Booster	Syringe Pump- Teledyne ISCO 500D
Acoustic Reactor System – Capacity	1L
PicoScope	1MHz higher frequency for noise removal



Acoustic wave velocity measurement reactor

In-situ Thermal conductivity measurement reactor



Thermal Conductivity Measurement system

Gas Booster

Gas Hydrates lab facility at NIOT

8.4 ELECTRONIC SUPPORT FACILITIES, MARINE SENSOR SYSTEMS

Marine Sensor System group has established the following electronic facilities for testing the components developed under NIOT projects.

Shock & vibration test facility

Shaker is used to test a device. The device will undergo test in three modes of vibration namely sine, random and shock each in vertical or horizontal direction before transferring components to project sites.

Parameter	Values
Sine(Pk)	3000kgf
Random(Rms)	3000kgf
Displacement(Pk-Pk)	50mm
Usable Frequency	0-3,000 Hz
Armature Diameter	400mm
Maximum Acceleration	100g

Corrosion testing chamber:

Parameter	Values
Test Space Volume	1000 Litres
Specimen Load	250kg

Corrosion chamber is for checking the corrosion resistivity of the material under test

Environmental chamber:

Parameter	Values
Test Space Volume	1500 Litres
Temperature range	-45°C to +180°C
Humidity range	10 to 98% RH
Heating rate	3.5 K/min
Cooling rate	2.5 K/min
Rated power	11.5kW

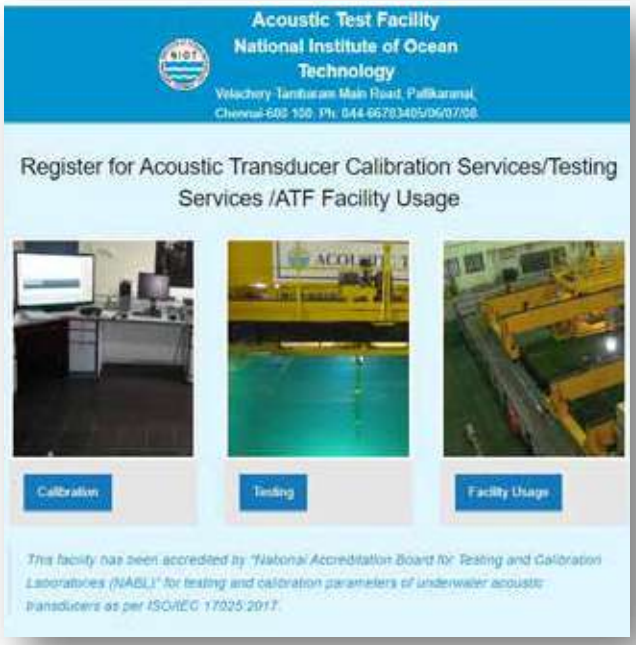
Environmental chamber is used for testing of device in the temperature range of -45° C to +180°C and Humidity range of 10 to 98% RH.

8.5 ACOUSTIC TEST FACILITY

National Institute of Ocean Technology (NIOT) under the Ministry of Earth Sciences (MoES), Government of India, has set up an underwater Acoustic Test Facility (ATF) to cater to the needs of underwater acoustic transducer calibration, in the frequency range 100Hz to 500 kHz, for national research laboratories, academic institutes and industries. The test facility is equipped with Acoustic Transducer Positioning System (ATPS) which was exclusively developed for positioning the transducers and systems in an Acoustic tank.ATPS is an integrated system consisting of mechanical, hydraulic and instrumentation equipment. Two special purpose trolleys are operated in long travel and cross travel and also have 3 axes movement. This facility has been accredited in the year 2005 by National Accreditation Board for Testing and Calibration Laboratories (NABL) for calibration of hydrophones as per IEC 60565 and the accreditation is renewed periodically.

Vibrating water column based low frequency calibration setup for the frequency range from 100Hz to 1 kHz has been established at ATF. Here hydrophone under calibration is immersed in a water column and the position of the hydrophone is kept constant while the fluid column is moved sinuously up and down. The up and down motion of cylinder is made by vibrating shaker and this vertical motion is transferred to the water which will generate the low frequency acoustic pressure in the water column. Corrections are then taken into account for system's own frequency response.

Laboratory quality management system (LQMS) is an online based application software developed in-house, as per the requirement of ISO/IEC 17025:2017 standard. The LQMS includes database for laboratory management system documents, day to day periodical records, maintenance of calibration certificates, equipment history, database for measurements made, internal audit process, online user request, review and approval, calibration scheduling, feedback etc.



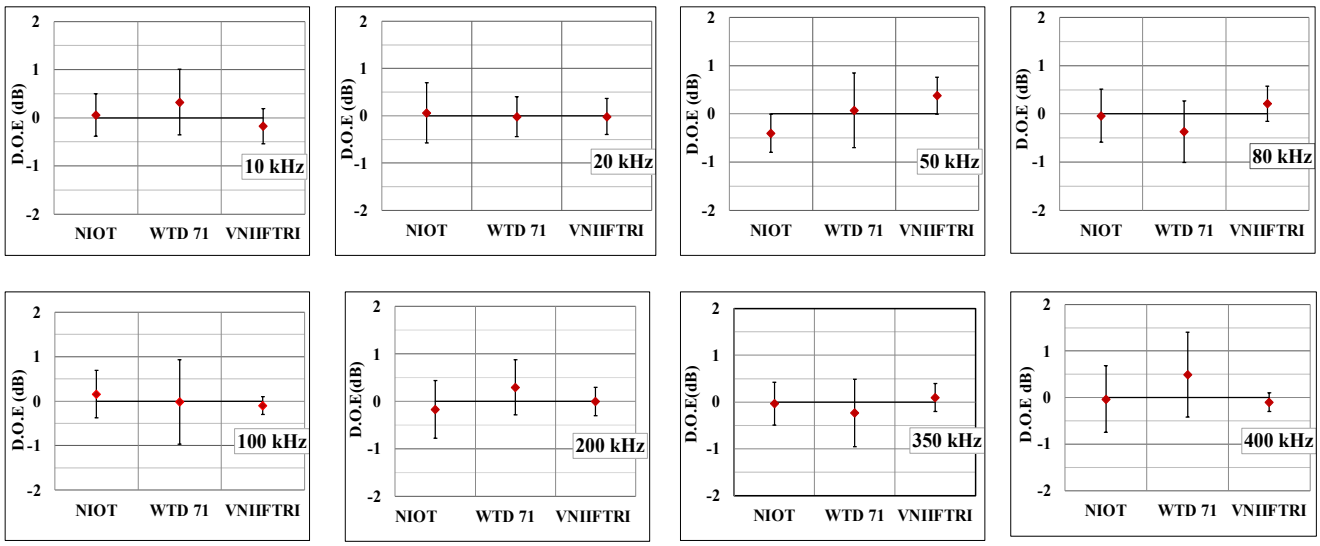
Online user request

Laboratory Quality Management System Application

Accreditation

- Participated in Inter Lab Comparison with VNIIFTRI, Russia and WTD 71 Germany during 2013.
- Participated in Key Comparison organized by National Physical laboratory, UK Consultative Committee on Acoustics, Ultrasound, and Vibration (CCAUV-W.K2): free-field calibration of hydrophones in the frequency range 250 Hz to 500 kHz during May 2018 along with 7 participants from UK, Turkey, Russia, USA, South Africa, China, Brazil.
- The ILC results establishes that the hydrophone calibration at ATF NIOT conforms with the International standards and on par with the internationally acclaimed laboratories.

• **The degree of equivalence (DoE) is in very good agreement for the entire frequency range for all the three laboratories.**



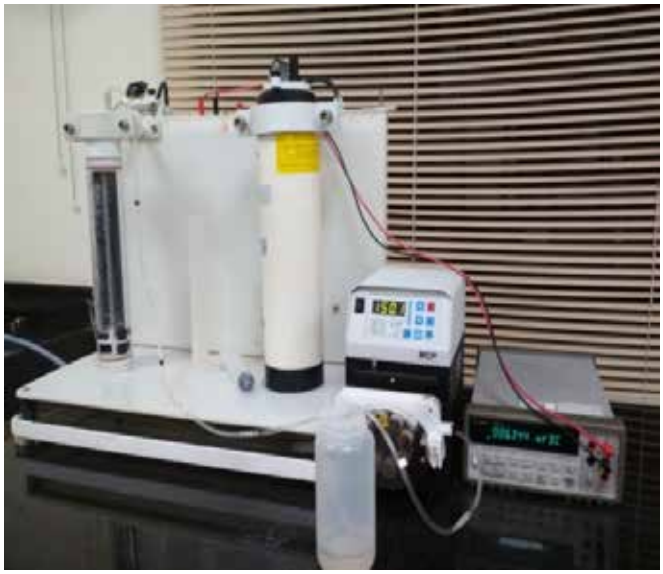
ATF, NIOT is the only accredited acoustic facility available in India and successfully proven the quality of calibration by participating in two interlab comparison with other standard institutes. Hence ATF, NIOT is currently in the process of obtaining Nationally Designated Laboratory status in underwater acoustics in India, through CSIR NPL Delhi.

8.6 CALIBRATION TEST FACILITY (CTF)

To ensure the quality of the measurement from the sensors, OOS, NIOT has established State-of-art Calibration Test Facility (CTF) along with standard calibration procedures. As a part of this activity, the quality of the data from different types of meteorological and oceanographic sensors viz. anemometer, pressure sensors, temperature and humidity sensors etc., in the real time is an important standardization parameter to improve the certainty level among the scientific community during real time data collection of met-ocean parameters. As a part of this standardization procedure, these met-ocean sensors are required to be calibrated every time, i.e., pre deployment and post deployment calibration.

NIOT is equipped with reference sensor recommended by WMO for RIC laboratories. i.e. Reference chilled mirror to calibrate Air Humidity sensor, Platinum Resistance Thermometer to calibrate Air temperature, Digital Gas piston gauge to calibrate Air pressure, peristaltic pump to calibrate precipitation, salinometer for salinity measurement, turn table to calibrate the digital compass and standard digital source to calibrate analog channels in CPU. Established calibration laboratory could help other similar organizations in the country.

Calibration of salinity

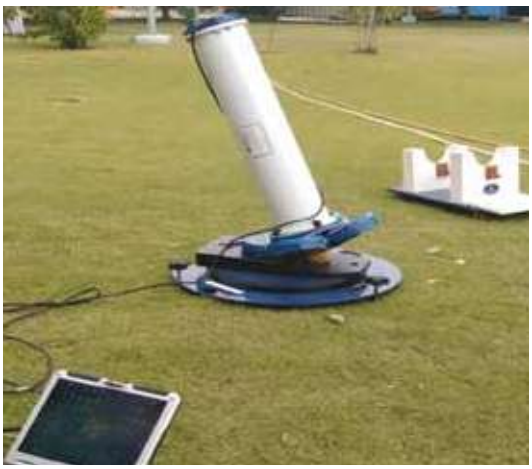


Calibration of Precipitation

Calibration of Digital compass

Digital Gas Piston Gauge-
Barometric pressure sensor calibration

Chilled mirror and PRT
Air temperature and Humidity sensor calibration



ADCP- Compass calibration

Flow bench
Precipitation sensor calibration

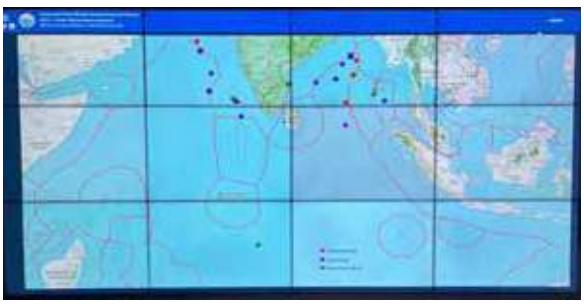
ADC calibration

Tsunameter Test facility:

Ocean Observation system is developing Indian Tsunami Bottom Pressure Recorder (ITBPR). The Tsunameter Test Facility was established in NIOT to test the functionality of ITBPR by simulating tidal variations. The imported BPR measured the sea level variations from the seabed. The mean value (i.e depth) removed, the sea level variation is feed to vertical arm which is fixed with the pressure sensor to test the functionality of ITBPR.

OOS Data Centre - CORNEA:

CORNEA (Centre for Ocean Realtime iNformation viEw and Archive), the Mission Control Centre of OOS has high end servers with high availability. CORNEA handles large quantum of data from the buoys and is being archived & provided on near real time to INCOIS-Hyderabad. The Ocean Data Centre CORNEA is envisioned to increase information quality, improve overall efficiency and effectiveness in the buoy data management with convenience in operations.



'CORNEA' the Mission Control Centre of OOS

An integrated software tool by name ADDRESS (ADvanced Data REception & analysiS System) was developed for real time data reception, data visualization, data analysis, data Quality Control(QC), Cruise, Inventory and Operation management.

ADDRESS allows processing of Complex and Non-heterogeneous data files, permit objective analysis, interactive exploration, analysis and visualization of Meteorological, Oceanographic data and other geo-referenced profiles for instant data visualization and monitoring buoy watch circle. Ultimately, it reduces manual interaction and encompasses diverse techniques for suggesting conclusions thereby supporting decision making, assimilate and provide data management dashboard resulting in an integrated information system.

8.7 LABORATORY FOR OSTI

MBT-Marine Biotechnology laboratory at NIOT Chennai is equipped with sophisticated instruments for supporting the research activities in marine microbial biotechnology, marine microalgal technology, open sea cage culture and ballast water testing and treatment, which includes various types of upright, inverted microscopes and Scanning Electron Microscope for imaging the biological specimens. Analytical and preparative HPLC, LC-MS, GC and GC-MS for qualitative and quantitative analyses of extracted bio-molecules. UV-visible wavelength spectrophotometers, polarimeter, spectrofluorimeter and FT-IR for spectroscopic investigations of isolated biomolecules. Gradient, RT PCR, electroporator, long read next generation Nanopore sequencer, gold standard Sanger sequencerto decipher the molecular characteristics of the isolated novel microorganisms as shown in the below figures. The microbial facility is equipped with various types of laminar flows, temperature controlled, incubators and shakers CO_2 incubators, freezers, and a cry storage facility. The lab is also equipped with a unique high-pressure low temperature sampler and a system for the isolation and culture of deep-sea microorganisms. A high-performance computational facility for advanced omics analysis and maintenance of nucleic acids and protein sequences databases. The group has also various types of Photobioreactors, Pilot scale raceway ponds for testing and standardization of mass culture of marine microalgae.

A

B

C

D

(a) HPLC and UHPLC systems (Thermo Scientific UltiMate 3000), (b) High Pressure serial dilution system and fermentor, (c) Scanning Electron Microscope (Joel JSM-IT500 In Touch Scope™), and Sanger Sequencer (ABI Seq Studio flex).

ACOSTI-Port Blair : Atal Center for Ocean Science and Technology for Island (ACOSTI) is a field cum marine biological laboratory situated in a sprawling 20 hectares campus encompassing 16 hectares of aquaculture demonstration farm, and 2500 square meters of administrative cum laboratory complex at Minnie Bay, Port Blair. The center has seawater intake facility, wet laboratory, OBM boats, various marine biological sampling gears, SCUBA diving equipment, advanced analytical equipment and laboratory for carrying out research in marine biology and biotechnology.

8.8 COMPUTER MAINTENANCE CELL

The Computer Maintenance Cell (CMC) of the National Institute of Ocean Technology, acts as the nerve centre, established in 1997 to provide computational and infrastructure facilities for the research community. CMC administers, manages and caters to the needs of different projects, and departments within the institute apart from in house software development and maintenance.

CMC services the campus-wide Local Area Network (LAN) which caters close to 500 users. LAN has been designed with a single-mode fibre OFC (Optical Fibre Cable) backbone offering aggregate bandwidth of 1 Gbps.

NIOT has dedicated leased lines of 1 Gbps and 30 Mbps capacity from NIC (National Informatics Centre) and Vodafone respectively to ensure uninterrupted service to the user community.

CMC also maintains the telepresence facilities of the campus and extends support for computational, presentation and Wi-Fi needs for seminars, conferences and workshops. Wi-Fi installations are enabled in Panikkar Hall, Varuna Hall, Rajendra Chola Hall and also in the Guest House facilities.

CMC has supported International Seabed Authority (ISA) workshop, for which delegates from different nations have attended in person and virtually.

Launch of New website

NIOT has launched a new website complaint with all the security norms and statutory requirements. It is a trilingual website in Tamil, Hindi and English.

8.9 CAMPUS DEVELOPMENT AND MAINTENANCE

Campus Development – New Infrastructure facilities and maintenance activities

To cater the requirement of research activities of different groups at NIOT campus the following civil and interior activities have been completed.

Civil Works

Design and construction of Mezzanine floor at BTF Building



Design and construction of temporary shed for DSM group



Design and execution of Civil work for EFW group



8.10 KNOWLEDGE RESOURCE CENTER (NIOT-KRC)

NIOT Library plays a major role in facilitating research and development since 1995.and presently renamed as "ज्ञान संसाधन केंद्र" i.e. "Knowledge Resource Center" and upgraded with workstations. The KRC is an integral part of the organization and provides a safe, comfortable and friendly environment that enables learning and advancement of knowledge and promotes discovery and research.

The KRC has a good collection of scientific reference books particularly related to oceanographic, biotechnology, and engineering discipline. KRC holds an excellent print collection of over 5650 volumes of books including scientific thesis, reports, NHO Maps, Administrative and Hindi books. KRC subscribes to 21 scientific e-journals, available **"24 x 7"** in real time on institute-wide network and also off-campus access to e-resources are avilable.

The subscribed journals includes American Society of Mechanical Engineers (ASME), American Institute of Physics (AIP), American Society of Civil Engineers (ASCE), Marine Technology Society (MTS), Institution of Electrical and Electronics Engineers (IEEE), Earth and Environment Science by Springer, Elsevier and Nature Publishing group etc. with online access for the year 2022 (costing approx. Rs.15 lakhs). The online journals are linked through the Institute's IP address.

In addition, MoES has been offering facilities through MoES-KRC portal under consortium, including 128 Science Direct journals and Nature magazine, complimentary access for citation databases like Scopus & Web of science. Also, digital repository services for dissemination of NIOT publications are available. All digital resources are renewed based on the usage statistics every year.

Access to foreign journals published by Elsevier and Nature Publishing Group, and journal collection package published by Springer and the 'Web of Science' database are also made available under the MoES Digital Earth Consortium (DERCON).

OTHER ACTIVITIES

9. OTHER ACTIVITIES

9.1 IMPLEMENTATION OF OFFICIAL LANGUAGE

In its pursuit of developing reliable indigenous technology for the sustainable utilization of ocean resources and advancement, NIOT, as a technical institute, has consistently integrated the use of the official language. Despite the majority of the workforce at the institution originating from region 'C', officials have consistently ensured that scientific and technical reports and publications are produced in both the regional language, Tamil, and the official language, Hindi. This trilingual approach has been successfully achieved to the highest degree. However, NIOT remains committed to continuously seeking innovative ways to seamlessly integrate scientific endeavors with the use of the official language as well.

Hindi Training

As per the guidelines for the implementation of the Official Language policy, Hindi training is provided to all employees, aided by HTS officials. In the session conducted in January 2023, 17 staff members were nominated for the Prabodh and Parangat courses (Prabodh-07 & Parangat-11). Diligent endeavors are underway to promptly extend training to the remaining employees as well.

Hindi Typewriting Course

Staff members who have to undergo typewriting course are regularly registered for it. During the latest session, two employees were nominated for the Hindi typewriting course and have successfully finished it. They are rewarded with personal pay increments and cash awards in accordance with the government's policy to incentivize the acquisition of Hindi typewriting skills.

Hindi Fortnight Celebrations

Aligned with the increasing usage of Hindi among the staff, NIOT observes Hindi fortnight annually. Following directives from the Department of Official Language, Ministry of Home Affairs, for the period of 2022-23, the Hindi Fortnight festivities were commenced by participating in the All India Official Language Conference on September 14, 2022, in Surat, Gujarat. Our institute was represented by three staff members at this event. From September 19th to 28th, 2022, the institute commemorated the Hindi fortnight. A range of competitions including debates, essay writing, extempore speaking, handwriting, quizzes, and text reading were organized to inspire staff members towards the use of Hindi. Active involvement was witnessed from all the officials in these contests and coordinating activities.

To ensure equitable opportunities for all officials, especially those from non-Hindi speaking states, prizes were separately awarded to both categories, fostering healthy competition. This approach generated enthusiasm among all staff members, including those who are not fluent in Hindi, as they wholeheartedly engaged in these competitions.

NIOT has also introduced a Noting competition to encourage staff members to conduct more administrative work in Hindi. The fortnight culminated on September 28, 2022, with the distribution of prizes to the competition winners. The Valedictory function was presided over by Dr. G.A. Ramadass, Director of NIOT.

Hindi Workshops

The Hindi Section at NIOT arranges a workshop every quarter on diverse subjects to enhance employees' grasp of Hindi and encourage increased usage of the language. The workshops held during this period are centered on "Administrative Glossary and Noting & Drafting" led by Smt. Maheshwari Ranganathan, Senior Official Language Officer; "E-office and Official Language" presented by Ms. ShwetaVerma, Hindi Instructor from HTS; and "Hindi Grammar, Word Formation, and Official Language Policies" facilitated by Shri P Loknath, Assistant Director at the O.L. Air Force Station Tambaram. These workshops spurred active engagement and interaction among the staff members.

Additionally, a one-day Hindi seminar took place at the institute on December 20, 2023. Dr. Deenanath Singh, Member Secretary of TOLIC and General Manager of Southern Railway, graced the event as the chief guest. The seminar, guided by ShriManojAbusaria, Joint Director of Official Language, and Dr. KusumLunia, Non-Official Member of the Hindi Advisory Committee, Ministry of Earth Sciences, featured various sessions. The first session encompassed a Hindi workshop and a technical presentation. Ms. ShwetaVerma, a Hindi Professor from the Hindi Teaching Scheme, conducted a workshop on "Office Vocabulary, Short Notes, and Grammatical Mistakes." Following this, Dr. KV Subramanian, a retired meteorologist, delivered a technical talk on "Understanding the Fallacies in Weather Predictions."

The second session of the seminar hosted a debate competition and a Tamil-Hindi poetry symposium, both of which witnessed enthusiastic participation from all staff members.

Official Language Implementation Committee meetings

Periodically scheduled Official Language Implementation Committee (OLIC) meetings are held to assess the Hindi usage among staff members, in accordance with the guidelines and progressive usage of the language. During these meetings, committee members present their

suggestions to enhance the implementation of the Official Language, and subsequent actions are undertaken to put these suggestions into effect. Four meetings of the Official Language Implementation Committee took place in the year.

Quarterly and half yearly reports for progressive use of Hindi

Quarterly reports (online) on the implementation of Official Language-Hindi for the respective quarter endings are sent to Regional Implementation Office, Cochin and MoES, New Delhi within the stipulated period of time. The half yearly report to the Town Official Language Implementation Committee is also submitted in the prescribed format within time.

E-Magazine in Official Language

NIOT launched its first Hindi edition of the 'Samudrika' e-magazine on 16 January, 2020, in the auspices of the Chairperson of Second Sub-Committee of Committee of Parliament on Official Language. The magazine is released biannually on a regular basis. The sixth edition of e-samudrika was released on 20 December 2023 covering articles of technical and literary nature.

Participation in TOLIC meetings and competitions

The Head of the Institute participated in all the bi-annual meetings of the Town Official Language Implementation Committee (TOLIC). Furthermore, NIOTians actively participated in diverse events and competitions conducted periodically by TOLIC.

9.2 CONFERENCES / WORKSHOPS

Indian Coastal Inlets Restoration Program (ICIRP)

- The Workshop for Stakeholders on Indian Coastal Inlets Restoration Program (ICIRP) was held at NIOT Chennai on 14th September 2022 and on 20th September 2022 in Trivandrum, Kerala which was attended by various departments of the states. The main objective of the workshop was to highlight the importance of coastal inlets and its functional performance.

I-CIRP stakeholder workshops at Chennai and Trivandrum

National Academic and Industry Conclave (NAIC 2023)

- A brainstorming session with industry, R&D and future stakeholders for ocean energy, seawater desalination, offshore structures and coastal environmental engineering technologies was held on 20th January 2023.

Sea Tech Week 2022 Conference

- As part of Sea Tech week 2022 conference during 25-30th September 2022 held in Brest, France, an Indo-French NIOT-IFREMER session named 'France-India Workshop on Ocean Technology towards advanced Knowledge and Sustainable Development' was conducted on 28th September 2022. The session was conducted in two parts i) Underwater Vehicles and Instrumentation and ii) Technologies for a Sustainable Ocean and Environment and Blue Economy. During Sea Tech week, NIOT Scientists and the Director, NIOT visited IFREMER laboratory facilities as it is beneficial to the ongoing programs of NIOT.

Welcome address by Dr. Dhilsha Rajapan during the session

Visit to Ocean Spectrometry lab

Knowledge workshop on Deep Sea Mining (DSM)

- Deep Sea Mining of mineral resources has been attracting attention around the world and is an industry on the threshold of starting. The global thrust on green technology, renewable energy and electric vehicles has resulted in the rising demand for Cobalt (Co), Nickel (Ni), Copper (Cu) and Rare Earth Elements (REE).

- MoES, GOI/NIOT and FICCI thus have jointly partnered in conducting a Knowledge Workshop on the Prospects of Deep-Sea Mining in sensitizing the Indian industry, policy makers and academia on the opportunities in the aforementioned area. The workshop was held at NIOT, Chennai on 27th January 2023 and was attended by renowned industrialists and policy makers and academic institutions like IITs etc

- Keeping with the aims of the Deep Ocean Mission, the Knowledge Workshop, jointly organized by MoES, GOI/NIOT and FICCI, on the Prospects in Deep Sea Mining, aims to bring out to the Indian Industry, Policy Makers and Academia, the resource potential,

technology development work undertaken, demystifying aspects of environmental impact, economics of deep-sea mining, opportunities that exist and the need for an enabling environment in terms of regulations and policy making

Mining workshop at NIOT



Workshop sessions and inauguration at NIOT

iCEN

- Industrial meet on Technology for cage culture of marine fins fish (iCEN-69) and Biofuel and Bioenergy (iCEN-72) was conducted jointly by Ministry of Science & Technology and Ministry of Earth Sciences, Government of India, on 4th October 2022 through online.

9.3 IMPORTANT DAYS OBSERVED AT NIOT

World Environment Day

- World Environment Day was celebrated on June 3, 2022 at NIOT, Chennai. Dr.G.A.Ramadass, Director NIOT addressed the gathering and tree saplings were planted in NIOT campus as part of this event.

Vigilance Awareness Week

- NIOT observed Vigilance Awareness Week from October 31, 2022 to November 6, 2022 and e-pledge was taken by NIOT staff at their respective work places. As a part of Vigilance Awareness Week activities, a workshop on the Topic “Preventive vigilance on the procurement of Goods & Services” was conducted by Shri. A Chidambaram, Registrar, IIITDM, Kanchipuram

Independence Day Celebration

- The 76th Independence Day was celebrated at NIOT campus and flag hoisting was done by Director NIOT on August 15, 2022 and addressed the gathering.

Republic Day Celebration

- NIOT celebrated 74th Republic Day on 26th January 2023. Dr.G.A. Ramadass, Director NIOT hoisted the national flag and delivered the speech on achievements and forthcoming commitment and deliverables to NIOT staff and scientists.

Foundation Day of NIOT

- The 29th Foundation of Day of NIOT along with the 25th year foundation of the Ocean Observation Systems erstwhile National Data Buoy Programme was celebrated on 14th November 2022 at NIOT, Chennai. The Chief Guest – His Excellency Mr. Hans Jacob Frydenlund, Norwegian Ambassador to India, participated as the Chief Guest along with Dr.M.Ravichandran, Secretary MoES and Dr.G.A. Ramadass, Director NIOT. Former Secretaries of MoES, Former Directors of NIOT, Directors of MoES were honored during the function. Foundation day lecture was delivered by the Chief Guest.He also released the E-Samudrika newsletter. As a part of this event, best employee awards to the nominated NIOT staff was presented by the Chief Guest.

Felicitation by the Chief Guest to Former Secretary, MoES (erstwhile DoD) Dr.A.E.Muthunayagam

Felicitation by the Secretary, MoES to Former Director, NIOT Prof M.Ravindran

NIOT Officials felicitated for completion of 25 years of service along with delegates during Foundation Day of NIOT

- Secretary, MoES launched the "Indian Coastal Inlets Research Program" (ICIRP) web portal during the foundation day. The portal is for the dissemination of ICIRP activities of NIOT and shall enable stakeholders' approach NIOT for coastal inlet restoration studies.

- A book titled "Rise of National Data Buoy Programme in Indian Seas" written by Shri K Premkumar, Former OOS Programme Director was released by Secretary MoES Dr.M.Ravichandran during the occasion.

International Women's day Celebration

- The International Women's Day was celebrated by NIOT on March 7, 2023 Dr.N. Anandavalli, Director, CSIR-SERC, Chennai graced the occasion as the Chief Guest and delivered the Women's day Special address. A booklet titled "**Women in Ocean Technology"** was released by the Chief Guest. Dr. G.A.Ramadass, Director, NIOT gave Women's day remarks. Several competitions were organized as a part of the women's day and prizes were distributed to the winners of the competitions. A week-long program comprising lectures by women scientists of NIOT and a program on financial management was also organized.

9.4 ISO CERTIFICATION

The change over to the new standard (ISO 9001:2015 standard) has been completed and implemented successfully. Internal Audits were conducted during July – August 2022 and January-February 2023. Management Review Meetings were conducted during August 2022 and February 2023 to review the outcome of the Internal Audits and to review the major changes in the Quality System which could affect the Quality Management System. The ISO 9001:2015 Surveillance audit for the administrative processes of NIOT was conducted by the external auditors from the accrediting body TÜV SÜD South Asia Pvt Ltd., Chennai and was successfully completed on 21.9.2022. The validity of ISO certification for ISO 9001:2015 is upto 08.11.2024.

9.5 VISIT OF DIGNITARIES

- LTTD plant at Amini and Kadamat generated fresh water in July 2022, and February 2023 respectively. Finishing works are in progress at Kadamat Island. Works in Androth, Chetlat and Kiltan Islands of UT Lakshadweep is in progress. Kalpeni and Amini LTTD plants were inaugurated by Hon'ble President of India Smt. Droupadi Murmu on 18th March 2023 in presence of Honourable Administrator, UTL, Shri Praful Patel, Senior officials and People of Lakshadweep, and, Officials of MoES-NIOT.

Inauguration of Kalpeni and Amini LTTD Plant by Hon'ble President of India

- On August 12, 2022, **Dr.Jitendra Singh,** Hon'ble Minister of State (Independent Charge) of the Ministry of Earth Sciences and Ministry of Science & Technology, visited **Sagar Anveshika** at Chennai Port and hoisted Tricolour onboard Ship as part of **'Har Ghar Tiranga, Har Jahaj Tiranga'.** The Hon'ble Minister reviewed the scientific capabilities of the Ship & praised the valuable contribution of the Research ship towards enhancing the knowledge on oceans & collection of valuable data.

- His Excellency Mr. Michael William Lodge, Secretary General, International Seabed Authority (ISA), accompanied by the following delegates from the ISA visited NIOT on 09

Feb 2023: His Excellency had a detailed discussion with the technical team working on deep sea mining project and also addressed the NIOT on ISA specific to Environmental Impact Assessment due to mining.

(a) Dr. Marie Bourrel McKinnon, Chief of Staff and Head of Strategic Planning Unit
(b) Dr. Jose DalloMoros, Director
(b) Dr. Sonakshi Mishra, Program Management Officer
(c) Dr. Madhumita Kothari, Senior Advisor

Secretary ISA visit to NIOT

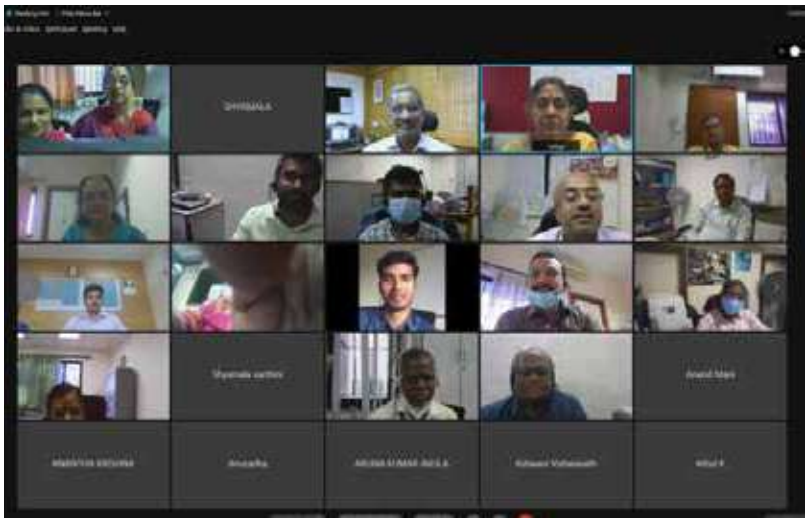
Speech – Secretary ISA at NIOT

- Dr.Chin-Tsan Wang Counsellor & Director, Science and Technology division, Ministry of Science and Technology, Taipei Economic and Cultural Center in India visited NIOT on 13th May 2022.

- Honourable Minister for Fisheries, Kerala Government visited the site and interacted with NIOT on 8th December 2022 and KSCADC officials regarding Shore Protection work for Poonthura. The Investigation plan and bathymetry grids was submitted to KSCADC.

9.6 SWACHHATA PAKHWADA

Swachhata Pakhwada



- Swachhata Pakhwada at NIOT was conducted from July 1-15, 2022. Cleanliness campaign was undertaken inside the NIOT campuses at Chennai, Atal Centre for Ocean Science and Technology in Islands (ACOSTI), Port Blair. Steps were taken to follow all the CoVID protocols such as wearing masks, hand gloves and use of hand sanitizers. NIOT also conducted a cleanup campaign outside the campus at Pallikaranai to create awareness about the importance of a cleaner environment and also keep the surroundings free of litters and plastics. Beach clean-up was undertaken at Tuppilipalem near the NIOT Seafront site at Pamanji.

Swachh Sagar, Surakshit Sagar

- National Institute of Ocean Technology implemented the "Swachh Sagar, Surakshit Sagar" campaign of the Ministry of Earth Sciences, Govt. of India in eight beaches in Tamil Nadu and ten beaches in A&N Island from 5th July – 17th September 2022. As a part of this campaign "Sagar Shanivar" celebration, various on-beach and off- beach awareness activities have been conducted in the beaches in TN and A&N. Dr.Jitendra Singh Hon'ble Minister of State (I/C), Ministry of Earth Sciences, Ministry of Science & Technology, participated in Sagar Shanivar Celebration at Kovalam Beach, Chennai on 13.8.2022.

- Meetings with Indian Coast Guard, Joint Commissioner of (Health) GCC, various government organizations and NSS have been organized. Press meet was jointly organized by NIOT, MoES and Vigyan Prasar at Periyar Science and Technology Centre, Chennai on 27.8.22 for creating mass awareness through press and social media. The grand culmination event of "Clean Coast Safe" sea campaign was organized as a mega programme by NIOT in all beaches in TN and A&N on 17.9.2022 jointly with Indian Coast Guard and other participating government and social organizations.

- Hon'ble Shri L Murugan Minister of State, Ministry of Fisheries, Animal Husbandry and Dairying and Ministry of Information and Broadcasting & DIG Shri Manjeet Singh Gill, Commanding officer Indian Coast Guard Ship Sagar, participated in the culmination event at Besant Nagar Beach. Shri Keshav Chandra, IAS, Chief Secretary, A & N Islands, Shri Narendra Singh, DIG, Indian Coast Guard, Port Blair and Shri Suneel Anchipaka, IAS, Deputy Commissioner, South Andaman participated in the culmination event at Carbyns Cove Beach Port Blair.

10. AWARDS / RECOGNITIONS

- Dr. Purnima Jalihal, Scientist-G, was selected among 21 women from India and Canada from the fields of Science, Technology, Engineering, Arts and Mathematics (STEAM), Jointly by Red Dot Foundation in partnership with The Office of the Principal Scientific Adviser to the Government of India and featured in the second edition, She Is - Women in STEAM in September 2022.

- Dr. Prince Prakash Jebakumar, Scientist-E, received the "Dr APJ Abdul Kalam Best Scientist and Distinguished Fellow Award 2022 - 2023" by the Bose Science Society established under the charter of Tamil Nadu Scientific Research Organization on 28th February 2023 in recognition of dedicated services in the field of scientific research & education.

- Dr. Prince Prakash Jebakumar, Scientist-E, received the "International Nobel Research Award" from the International Society for Scientific Network Awards and Congress 2022 (IISTAC 22). For the research & Excellence in Marine Ecology / Eco-Friendly Technology Development.

- Smt. Anulekha Majumdar, Scientist-D, received the Subrath Kumar Malik Prize for securing highest CGPA in the first two semesters of M.Tech programme in Ocean Technology at IIT Madras on 26 April 2022.

- Smt. Shweta Lokhande, Senior Research Fellow, received best poster presentation award in the poster session for presenting "Vector Sensor Array processing for underwater source localization", in the Research scholars' day 2022, organized by MIT, Chennai on September 5, 2022.

- Shri. K. Thirumurugan, Scientist-D, received the best employee award for Excellence in Scientific and Technical contribution from Norwegian Ambassador to India in the presence of Secretary MoES and Director NIOT during 29th NIOT Foundation Day on 14th November 2022.

- Shri.Sreedev D S, Scientist-E, received the 'Young Technologist Award' of NIOT during NIOT's foundation day.

11. PATENTS / TRANSFER OF TECHNOLOGIES (TOT)

Patents Awarded

S.No.	Inventors	Title	Awarded reference	Country
1	M.Ashokan, G.Latha, G.Raguraman, Thirunavukkarasu	A computer implemented System for transmitting High frequency Ocean ambient noise in Real time (SHOR)	394789 Dt. 13.04.2022	India
2	Shijo Zacharia Dhilsha Rajapan Shibu Jacob Atmanand M.A	An anti-biofouling system and a method thereof	400373 Dt.29.06.2022	India
3	D.Muthukumaran, V.Doss Prakash, A.Vadivelan, S.Elangovan, E.Chandrasekaran, M.Murugesan, M.Radhakrishnan	A Water Proof LED Array Lighting System for Oceanographic Applications	406787 Dt.16.9.2022	India
4	Boby George, Jegadeesh Kumar, Tejaswini, Bijoy, Srinivasan. R, Tata Sudhakar Atmanand.M.A.	Devices and methods for conductivity measurement of liquids	410165 Dt. 28.10.2022	India
5	Sreedev D.S, Shijo Zacharia, Dhilsha Rajapan, Shibu Jacob, Atmanand M.A.	A networkable hydrophone array for providing simultaneously digitized data	418913 Dt.23.01.2023	India
6	Kirubagaran R, Thirupathi K, Ramesh N.R, Atmanand M.A	Apparatus for Deep-sea Microbial Culture and method thereof	423452 Dt.28.02.2023	India
7	Srinivasan. R, Shijo Zacharia, Tata Sudhakar, Thamarai. T, Gowthaman. V, Atmanand.M.A	A Smart sensor drifting buoy node with INSAT communication for meteorological and oceanographic applications	423800 Dt.02.03.2023	India

8	G. A. Ramadass, S. Ramesh, D. Sathianarayanan, R. Ramesh, G. Harikrishnan, A. Vadivelan, N. Vedachalam, A.N. Subramanian, E. Chandrasekaran, D. Muthukumaran, M. Murugesan, S. Elangovan	A polar Remotely operated vehicle	427580 Dt.29.03.2023	India

Patents Filed

S. No.	Inventors	Title	Filed Application No.	Country
1	R.Venkatesan M.Arul Muthiah B.Kesavakumar K.Thirumurugan G.Vengatesan R.Sridharan	System and method for fishing vessel based smart network for ocean observations	202241022590 TEMP/E-1/24933/ 2022-CHE Dt.17.4.2022 TEMP/E-1/ 35804/ 2021-CH Dt. 20.7.2021	India
2	C.Janarthanan, Gopkumar K, V.Sundaramoorthi, B.O.Vishwanath, V.Chandran, S.Rajesh, P.Muthuvel, G.A.Ramadass	Fail Safe Heavy-Duty Deep-Sea Lifting and Latching System for Deep Sea Mining Machine	202241071888 Dt. 13.12.2022	India

3	C.Janarthanan, Gopkumar K, V.Sundaramoorthi, V.Chandran, P.Muthuvel, G.A.Ramadass	Skid with Water Feed System for Fail Safe operation of Deep Sea Mining Machine	202241036854 Dt. 27.06.2022	India

Transfer of Technologies (ToT) to Industries

As a part of Indigenous technology developments, several ocean observation tools are developed and tested at field. These technologies are transferred to industries for commercialization through National Research Development Corporation (NRDC).

S.No	Title of the technology	Indian Industries	Year of transfer
1	Marine oil Spill Biormediation	M/s. Eco Build corp Ltd Bangalore	2022
2	Met-Ocean Buoy System type – I (MOBS-1)	M/s. Norinco Pvt Ltd Mumbai	2022
3	Sea water Lantern (ROSHINI)	M/s Printlay Technologies	2022
4	Sea water Lantern (ROSHINI)	M/s Porunima Water Technologies	2023
5	Sea surface temperature Sensor (SST)	M/s.Tridel Technologies	2022
6.	Mechanical Components of Moored Buoy System Type - 1	M/s. GRP Industries	2023
7.	Mechanical Components of Moored Buoy System Type2	M/s. GRP Industries	2023

12. PUBLICATIONS

International Journals

1. Velmurugan Puliankurichi Mookan, Sivaraj Sigamani, Rajesh Kumar Machakalai, Sundararajan Srinivasan, Prabhu Kolandhasamy, Palingamoorthy Gnanamoorthy, Meivelu Moovendhan, Ramachandran Srinivasan; *"Assessment of heavy metals contamination along the southeast coast of India, Bay of Bengal",* Multivariate Pollution Indices. Manuscript Number: MPB-D-23-00090; accepted Journal : **Marine Pollution Bulletin.**
2. PM. Velmurugan, M. Rajesh Kumar, S. Sundararajan and R.Jeeva Priya, M.S.Meer, "*Preliminary investigation on Prediction of Ocean Acidification in the selected locations in Palk Strait, Bay of Bengal using Seacarb software",* communicated to Journal of **Marine Science and Technology** (JMST).
3. Kiran, A.S., Ravichandran, V., Karpurapu, R, *"Stability of Upper Geotextile Tube in a Stacked Formation Under Wave Loading*. International Journal of **Geosynthetics and Ground Engineering,** Vol.8, 32, 2022.
4. C. S. Sandhya, S. Ramesh, N. Thulasi Prasad, K. N. V. V. Murthy, D. Gobichandhru, M. Murugesan, N. Vedachalam and G. A. Ramadass, *"Design and development of human metabolic simulator for a deepwater manned submersible",* **Current Science Journal,** Vol.122, Issue 2, 2022.
5. Narayanswamy Vedachalam, *"Assessment of the technological maturity of marine autonomous surface ships",* **Marine Technology Society Journal**, Vol.56, Issue 4, Pg:43-58, July/August 2022.
6. Manickavasagam Palaniappan, Narayanaswamy Vedachalam, *"Climate resilient and eco-friendly shipping: mapping the trends",* **Marine Technology Society Journal**, Vol.56, Issue 4, Pg:90-105, July/August 2022.
7. Noufal K.K, Sanjana M C, Latha, G, Ramesh R, *"Influence of Internal Wave Induced sound speed variability on acoustic propagation in shallow waters of North West Bay of Bengal",* **Applied Acoustics,** Vol.194, 108778, pp 1-7, April 2022. IF: 2.6.
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9. Madan M. Mahanty, Sanjana M. Cheenankandy, Ganesan Latha, Govindan Raguraman, Ramasamy Venkatesan, *"Acoustic Identification of Dolphin Whistle Types in Deep Waters of Arabian Sea Using Wavelet Threshold Denoising Approach",* **Archives of Acoustics,** Vol.48(1), pp.39-48, 2023.
10. Biswajit Haldar, Abhishek Tandon, Karakunnel Joseph, Manickavasagam Arul Muthiah, Puniyamoorthy Senthilkumar, *"Remapping of Temperature Profile Measurements in OMNI Buoy Systems",* **Marine Technology Society Journal,** Number 6, November/December 2022, pp. 46-57(12).
11. Shyamala Varthini Dinakaran, Kiran Raju Alluri, K Jossia Joseph, M V Ramana Murthy and Ramasamy Venkatesan, *"Modelling and simulation of extreme wave heights around Agatti Island of Lakshadweep, West coast of India",* Front. **Built Environ., Sec. Coastal and Offshore Engineering,** Vol.8 – 2022, October 2022, https://doi.org/10.3389/fbuil.2022.991768.

12. Anoopa Prasad C, Martin V Mathew, Fabrice Papa, B Rohith, R Venkatesan and G Latha, Characterizing near-surface salinity variability in the northern Bay of Bengal and its potential drivers during extreme freshening years of the 2011-2019 period, **Dynamics of Atmospheres and Oceans,** Volume 102, June 2023, 101357.

13. Dilip Kumar Jha, Vikas Pandey, Chandrasekaran Muthukumar, Ponnusamy Sathish Kumar, Srinivas Venkatnarayanan, Jebarathnam Prince Prakash Jebakumar and Gopal Dharani (2022). Investigation of Coastal Water Characteristics Along the Southeast Coast of India: **A Multivariate Approach. Frontiers in Marine Science**. 9:945495. (I.F. 4.9).

14. Gajendra Joshi, Prasun Goswami, Pankaj Verma, Gopika Prakash, Priya Simon, Nambali Valsalan Vinithkumar , Gopal Dharani 2022. *Unraveling the plastic degradation potentials of the plastisphere-associated marine bacterial consortium as a key player for the low-density polyethylene degradation.* **Journal of Hazardous Materials**. 425, 5 March 2022, 128005(Elsevier I.F. 10.5).

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16. Josephine A., Vijaya Raghavan Rangamaran, Kumar Thalavai Sivashankarasubbiah, Nagendran Nagaraj, Dharani Gopal, Kirubagaran Ramalingam 2022. *An insight into the influence of random mutagenesis on growth and lipid accumulation in Chlorella vulgaris - a transcriptome study.* **Biomass Conversion and Biorefinery**. Springer (I.F. 4.9).

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33. Kesava Kumar, Palanisamy Shanmugam, Ramasamy Venkatesan (2022). *Enhanced Sea Surface Salinity Estimates using Machine-Learning Algorithm With SMAP and High Resolution Buoy Data,* VOLUME 10, 2022 10.1109/IEEE ACCESS.2022.3189784.

34. Martin M. V, R. Venkatesan, Robert Weller, Amit Tandon, K. Jossia Joseph, "Seasonal temperature variability observed at abyssal depths in the Arabian Sea", **Nature Scientific Reports,** September 2022, Vol.12(1), DOI:10.1038/s41598-022-19869-z.

National Journals

1. Srinivasan. R, Gowthaman. V, Tata Sudhakar and Ramadass. G.A., *"Adapting the Drone Technology for Marine applications – A high resolution water quality measurement system using drone – Part A"* is published in **Journal of the Institute of Marine Engineers**, Volume 16, Issue 10 - September 2022. Pages: 9-15.
2. Srinivasan. R, Gowthaman. V, Tata Sudhakar and Ramadass. G.A., *"Adapting the Drone Technology for Marine applications – A high resolution water quality measurement system using drone – Part B"* is published in **Journal of the Institute of Marine Engineers,** Volume 16, Issue 11 – October 2022. Pages: 14-21.
3. Srinivasan. R, Gowthaman. V, Tata Sudhakar and Ramadass. G.A., *"Adapting the Drone Technology for Marine applications – A high resolution water quality measurement system using drone – Part C"* is published in **Journal of the Institute of Marine Engineers**, Volume 16, Issue 12 – November 2022. Pages: 23-26.
4. D. Rajasekhar, Cdr.P.K.Srivastava, D.Narendrakumar, Ananthakrishna, P.S.Deepaksankar, Pratik Bose, AarushiAjit, Vibha DineshSharma *"Feasibility Study of Installing Rotor Sails Onboard Research Ship - A Novel Approach Towards Implementing Green Ship Technology",* Marine Engineers Review, **Journal of The Institute of Marine Engineers (India),** Volume: 16, Issue: 5, pg.9-16, April – 2022.
5. D Rajasekhar, D Narendrakuamar, Pratik Bose *"Green Shipping for Sustainable Future: A Technological Innovation towards Zero Emissions"* **Engineering Newsletter for Maritime Sector, The Institution of Engineers,** India, Volume: 3, pg.12-15, May 2022.
6. D. Menaka, Sabitha Gauni, Govardhanan Indiran, R. Venkatesan, M. Arul Muthiah (2022), *"A Heuristic Neural Network Approach for Underwater Parametric Prediction at Bay of Bengal",* **IETE Journal of Research** https://doi.org/10.1080/03772063.2022.2142686.

Book Chapters

1. Jalihal, P. (2023), *Augmentation of Water—Can Oceans Help?* In: Gahalaut, V.K., Rajeevan, M. (eds) **Social and Economic Impact of Earth Sciences.** Springer, Singapore. https://doi.org/10.1007/978-981-19-6929-4_13.
2. Shanmuga Priyaa S, Aruna Kumar Avula, Basanta Kumar Jena, *"Bathymetry Retrieval Using Remote Sensing Techniques for Inter-tidal Regions of Tapi Estuary"* Book Chapter in **River and Coastal Engineering**. August 2022. Doi: 10.1007/978-3-031-05057-2_19.
3. Vedaprakash, L., Senthilkumar, P., Inbakandan, D., Venkatesan, R. (2022). *Marine Biofouling and Corrosion Long-Term Behavior of Marine Structures.* In: Kamachi Mudali, U., Subba Rao, T., Ningshen, S., G. Pillai, R., P. George, R., Sridhar, T.M. (Eds) **A Treatise on Corrosion Science, Engineering and Technology. Indian Institute of Metals Series.** Springer, Singapore. https://doi.org/10.1007/978-981-16-9302-1_24.
4. Shri K Premkumar, Former Programme Director, OOS Group, NIOT *'Rise of National Data Buoy Programme in Indian Seas'*, November 2022.
5. K.N. Navaneeth, K Jossia Joseph, A review article titled "*Impact of COVID-19 Lockdowns on the Regional and Global Oceans and Coasts- Review of the COVID",* Special issue of Frontiers in Marine Science published in **Ocean Digest, Quarterly Newsletter** of the Ocean Society of India, Vol 9, Issue 01, Jan 2023, ISSN 2394-1928.

The Cumulative Impact Factor for the year 2022-23 is 162.82

The NIOT H-Index for the year 2022-23 is 2.

13. PAPERS PRESENTED IN CONFERENCES

International Conferences

1. Dr. Vijaya Ravichandran, *"Use of geosynthetics in nearshore dyke construction - concept, challenges, adaptability",* in the International Workshop on Geo-Textile technology and its application for Climate Change adaptation on 13 December 2022 organized at IIT Madras as part of 23rd Congress of the **International Association for Hydro Environmental Engineering and Research Asia Pacific Division** (IAHR-APD).
2. Avula Aruna Kumar, Muni Reddy. M.G, P.V.L Narsing Rao, *"Modelling morphological processes in the vicinity of river mouth due to partial closure of the river mouth"* 23rd congress of the International Association for **Hydro Environmental Engineering and Research – Asia Pacific Division 2022** (IAHR-APD2022), Department of Ocean Engineering, Indian Institute of Technology Madras, Chennai.
3. Jebarathnam Prince Prakash Jebakumar, Ganesan Nandhagopal, Bose RajanBabu, ShunmugavelRagumaran, Vijaya Ravichandran, "*Ecofriendly filtration technology for treating ballast water reconciles shipping impacts on the coastal ecosystem",* **Sea Tech Week 2022 conference held at Brest, France during 26-30 September 2022** - paper presented by Dr. Prince Prakash Jebakumar via recorded video.
4. Kesava Kumar B, Arul Muthiah M, Ramesh K, Vengatesan G, Jossia Joseph K, Venkatesan R, *"Performance of oceanographic sensors used in deep sea moored buoy systems in the Bay of Bengal and Arabian Sea during normal and extreme events"* is presented in **Sea Tech Week 2022 workshop which is jointly organized by India & France**, September 2022.
5. Lokesh Thiagarajan, Kiran A S, and Vijaya Ravichandran, *"Coastal zone management through sustainable techniques – case studies on erosion and accretion impacts",* Sea **Tech Week 2022 conference held at Brest,** France during 26-30 September 2022 - paper presented by Mr. Kiran A S.
6. Sreedev. D.S, K. Arumugam, P. M. Rajeshwari, M. Sankar, Shibu Jacob, DhilshaRajapanand G A Ramadass, *'Design and development of a dual mode low frequency sonar and its preliminary performance',* **SeaTech Week 2022, Brest, France**, 26-30 September 2022
7. Rahul. S, Sibani S, SK Rakshith, B. Pattanaik, S. Sutha and P. Jalihal, *"Data-driven Model Development and Validation for Laboratory Scale OC-OTEC Plant,"* 2022 **IEEE International Power and Renewable Energy Conference** (IPRECON), Kollam, India, 2022, pp. 1-6, doi: 10.1109/IPRECON55716.2022.10059574.
8. B. Pattanaik, S Sutha, B Thirumurugan, P Datta, S Sanjay, S Surya Prasanna V Vishnu, P Jalihal. *"Power and freshwater prediction against seasonal variation in OC-OTEC plant at Lakshadweep using DNN,"* 2022 IEEE **International Power and Renewable Energy Conference** (IPRECON), Kollam, India, 2022, pp. 1-6, doi: 10.1109/IPRECON55716.2022.10059529.
9. Daniel J. Hasselman, L.G. Hemery, J. Fox, A.M O'Hagan, I. Machado, A. Vishwanath, S. Narasimalu, D.M. Overhus, A.E. Copping, *'Scaling up'* Our Understanding of Environmental Effects of MRE Development from Single Devices to Large-Scale Commercial Arrays, **Proc. of International Conference on Ocean Energy (ICOE 2022), Ocean Energy Europe, San Sebastian** October 18, 2022.
10. Majumdar, A., Dudhgaonkar, P. and Jalihal, P., 2022, May. *Structural Modification and Optimization of AlSi 7 Mg 0.6 Alloy Based Rotor for Wave Energy Harvesting.* In 2022 **IEEE 7th International Energy Conference (ENERGYCON)** (pp. 1-6). IEEE.

11. Majumdar, A., A. Mani, and P. Jalihal. *"Structural analysis of low-pressure steam turbine rotor for Open Cycle Ocean Thermal Energy Conversion (OC-OTEC) based desalination plant."* Trends in **Renewable Energies Offshore** (2023): 897-905.
12. K.Thirumurugan, K.Shanmuga Sundaram, P.Murugesh, Tata Sudhakar, *"Indigenization of Buoy Components using Additive Manufacturing Technique"* in **2nd International Conference on Design, Materials and Manufacturing process (ICMDM-2023)** organized by College of Engineering Guindy, Anna University, Chennai during 23-25 February 2023.

National Conferences

1. Sunil Kumar Mohanta, Dr. G.Latha, Dr. M.C.Sanjana, Dr. E. Arunbabu, *"Soundscape in Summer in Kongsfjorden, Arctic"*, abstract submitted to OSICON 21, **Seventh National Conference of the Ocean Society of India** to be held during August 12-14, 2022.
2. Shweta Lokhande, G.Latha, S.Srinivasan, A. Malarkodi, *"Comparison of Vector Sensor Array processing algorithms for underwater source Localization"* abstract submitted to OSICON 2021, **Seventh National Conference of the Ocean Society of India** to be held during August 12-14, 2022.
3. Dr. Tata Sudhakar, GH, OOS and Dr. K. Jossia Joseph attended the International Symposium on Geophysical Flows and presented the **Technology Development and Applications of Indian Moored Buoy Network at IIT Chennai**, on 12 August 2022
4. Dhilsha Rajapan, D.S.Sreedev, P.M.Rajeshwari, M.Sankar, *'The importance of indigenous marine sensors and systems in maritime technologies'*, **34th National Convention of Marine Engineers,** NSTL, Visakhapatnam, 2nd -3rd December 2022.
5. Anand Kishore, Muthukumaravel. S, Venkatesan. G, Karthikeyan. A, Tata Sudhakar and Purnima Jalihal, *"A study on the volume expansion/contraction of Phase Change Materials and its Application in harvesting energy from cyclic environmental temperature variation"* is published in the **proceedings of the 9th International and 49th National conference on Fluid mechanics,** December 14-16, 2022 at IIT - Roorke.
6. D.Nikhil Sai Prasanna, A.Thirunavukkarasu, A.Malarkodi and G.Latha, *"Underwater acoustic scattering studies on the sub-sea pressure housings"*, in the **50th National Symposium on Acoustics - NSA 2023** held during 24-26, February, 2023, at VSSUT, Sambalpur, Odisha.
7. R. Kannan, R.Keerthivasan, G.Raguraman, M.C.Sanjana and G.Latha, *"An Acoustic Signature Investigation of a Marine Mammal (Tursiops spp.) in the Northern Indian Ocean"*, in the **50th National Symposium on Acoustics – NSA 2023**, held during 24-26 February, 2023 at VSSUT, Sambalpur, Odisha.
8. Shweta Lokhande, Malarkodi A, Latha G., *"Ship signature identification using Vector Sensor Array field experiment conducted at Chennai Harbor"*, in **50th National Symposium on Acoustics – NSA 2023,** pp.35, 24-26 February 2023, VSSUT, Sambalpur, Odisha.
9. Arun Siddharth, Avula Aruna Kumar, Abhishek Tavva, Dr. B. K. Jena, Dr. Purnima Jalihal, *"Planning and Design of short-term shore protection scheme for Ramachandi coast of Odisha based on shoreline change analysis using satellite imageries"*, **NRSC User Conference,** February 2023.

10. Sunil Kumar Mohanta, M.C.Sanjana, G.Latha, E.Arunbabu, *"Impact of COVID 19 lockdown on Underwater ambient noise"*, in **50th National Symposium on Acoustics – NSA 2023** pp.118, 24-26 February, 2023, VSSUT, Sambalpur, Odisha.
11. Prasad Dudhgaonkar, Biren Pattanaik, Purnima Jalihal, *"New Desalination Plant based on Acyclic OTEC for Kavaratti"*, **Hindi Scientific Workshop** organized by NCCR, February 2023.

Seminars / Webinars/Meetings / Training

- In-house training on "Orcaflex Mooring Analysis" Software was organized by an OOS team on 18/04/2022.
- Dr. Tata Sudhakar, Scientist-G & Group Head, OOS, and M.Arul Muthiah Sci-F participated in the meeting with IFREMER, France in connection to the Indo-France Joint workshop on "Ocean Technology towards advance Knowledge and sustainable development", on 27 April 2022.
- VMC team participated in webinar on "COP26 and the Brahmaputra- 04/06: A New Perspective Based on the Underwater Domain Awareness (UDA)" organized by Maritime Research Center on 5th April 2022.
- VMC team participated in webinar on "Digitalization and its impact on maritime operations" organized by DNV-GL on 26th May 2022 &"Indian Maritime Industry – Impact on Maritime and National Security" conducted by "Forum for River and Ocean Scientists and Technologists Odisha [FROST]" on 28th May 2022.
- OOS Scientists imparted training and delivered lectures about the Indian moored buoy program to IIT Madras Ocean Engineering MTech students from 06th June to 7th June 2022.
- VMC team participated in webinar on "Geopolitical cyber threats: best practices for critical infrastructure resilience" organized by DNV-GL on 23rd June 2022.
- The OOS Technical team participated in one day training program on data loggers conducted by M/s. Campbell Scientific, USA on 12th July 2022.
- OOS Scientists imparted one day training on moored buoy systems to the National Institute of Hydrography staff (commander level) on 08th August 2022.
- VMC team attended the IEI Technical Webinar on "Maintenance and Operational Strategies for the Mariners" organized by Navi Mumbai Local Centre of The Institution of Engineers (India) on 24th September 2022.
- OOS Scientists delivered a lecture about the Indian Moored buoy program to the new recruits of NIOT project scientist during the orientation program on 1st November 2022.
- Three days training programme on open sea cage culture was organized at ACOSTI, Port Blair, jointly with Department of Fisheries A&N, 25 fishermen participated in the training.
- VMC team attended the IEI-34th National Convention of Marine Engineers held at Visakhapatnam on 2nd December 2022 & presented technical papers on "Cyber Risk & Security Measures Onboard Research Ships -Strategy for Mitigating the Evolving Threat" & "Nano Material Additives: A Novel Approach towards Abatement of Ship's Emission".
- Dr.Vijaya Ravichandran chaired a technical session in the 23rd Congress of the International Association for Hydro Environmental Engineering and Research Asia Pacific Division (IAHR-APD) on December 15, 2022.

14. INVITED TALKS

Dr.G.A.Ramadass

- Chief Guest address on "Marine Biotechnology Prospective", at Alpha Arts and Science College on 12th April 2022.
- Delivered an invited talk on "Deep seabed mining prospects and challenges" at Gujarat Maritime University on 11th May 2022.
- Guest of Honour in the online webinar on Global Warning & Climate Change Cluster organized by AMITY University on 08th June 2022.
- Chief Guest in the valedictory event at Saveetha Institute of Technical and Medical Sciences, Velappanchavadi on 1st July 2022.
- Gave an Introductory Talk on "Ocean Technologies" in the I-connect event i-CEN-67 (E3OW) on 3rd August 2022.
- Delivered an invited talk in the National Webinar on Sustainable Development and Management of Artificial Reefs - Dept. of Fisheries (online), on 29th August 2022.
- Delivered a lecture as Chief Guest for Convocation Day of Meenakshi College of Engineering on 18th September 2022.
- Delivered an invited talk on "Deep Ocean Mission (DOM)" in the 3rd International Workshop on Numerical and Experimental Modelling of Wave Structure Interactions at IIT Madras on 12th December 2022.
- Panel discussion and delivered talk on the theme "Ocean Services, Technology & Blue Economy" at IIC, New Delhi held during 11th – 13th January 2023.
- Delivered an invited talk on "Technology for exploration of ocean resources" at the Vice Admiral KK Nayyar Fellowship Conference 2023, (KKNFC-2023), at New Delhi on 23rd February 2023.
- Delivered a Science Day lecture on "Recent Advances in Ocean Technology" in the Chettinad College, Kelambakkam on 28th February 2023.
- Keynote address in UT23 on "Technology for the Deep Ocean Exploration" on 8th March 2023.

Dr. Purnima Jalihal

- "Moving away from water stress- The road ahead", International Workshop on "Water Purification Technologies, Arsenic Removal from Groundwater and Integrated Water Management (IWWPT-2022),CSMCRI, June 30, 2022
- "OTEC : A Baseload Energy Source -Indian and OES Activities", ICOE-OEE 2022, Session- Market: From the Land of the Rising Sun to Down Under, October 18, 2022, San Sebastien, Spain
- "Ocean Energy- The Indian Scenario", World Resources Institute webinar on Ocean energy Potential and Future in India, Nov 24, 2022
- "Ocean Technologies for Energy, Water and Coastal Protection", Manohar Parrikar Vidynan Mahotsav , Goa, Dec 13, 2022.

Dr.D.Rajasekhar

- As a Key Note Speaker, delivered a technical talk on "Integration of Renewable Energy Technology for Smart Ships" in AICTE Sponsored ATAL Faculty Development Programme [FDP] held at AMET University, Chennai on 7th November 2022.

Dr. Dhilsha Rajapan

- Delivered an invited talk 'On Ocean Technology and its Relevance' as Chief Guest in the Department of ECE & Computer Science, Meenakshi Engineering College, K.K.Nagar on 23rd November 2022.
- Delivered an invited talk on 'The importance of Science &Technology for future Developing countries with special reference to Ocean Technology' to the higher secondary school students of the Sri Padmaseshadri School, OMR, Chennai through online mode on 19th November 2022.

Dr Tata Sudhakar

- Delivered a lecture as Chief Guest in the 1st International Conference on Computational Science and Technology (ICCST 2022) on 9th November 2022.

Dr. G. Latha

- Delivered a talk on "Acoustic monitoring of the oceans and applications" in the International Women's day celebration of IGCAR Kalpakkam held on April 7, 2022.
- Delivered a talk on "Real time applications in Oceans" in the 22nd National Conference on Science, Engineering and Technology of STEM (Science, Technology, Engineering and Management) VIT, Chennaiheld on June 2, 2022.
- Delivered a talk on "DigitALL - Innovation and technology for gender equality" in the International Women's day celebration of NCPOR, Goa as Chief Guest, held on March 1, 2023.
- Delivered a talk on" Numerical and Statistical Methods for Oceanographic Applications" Five Day Workshop on Recent Advances in Numerical and Statistical methods (RANSM2023), Anna University, Chennai held on March 9, 2023
- Delivered a talk on "Career opportunities that leverage mathematical talent" at Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women, Chennai held on March 13, 2023.

Dr. Vijaya Ravichandran

- Delivered a lecture on "Field testing of suction piles as foundations in coastal applications" at Meenakshi Sundararajan College of Engineering as part of ATAL FDP 2022-23 titled 'A boulevard to neoteric geotechnical engineering'on December 28, 2022.

Dr. Basanta Kumar Jena

- Delivered a talk on Progress and Prospects of Hydrographic Surveying Technology in R & D, Ocean Society of India (OSI) monthly Webinar.
- Delivered a talk on Indian Coastal Ocean Radar Network (ICORN) and its Application, Ocean Society of India (OSI) monthly Webinar.
- Delivered a talk on Project undertaken by NIOT on the Future Weather, Climate and Water across Generations at Indian Naval Air Squadron (INAS) 313, Met Office, Chennai.
- Delivered a talk on "Understanding the synergies between oceanography and geodesy" at INCOIS, Hyderabad.

Dr. S.V. S Phani Kumar

- Delivered an invited talk on Course on Ocean Technology, Hydrodynamics and Risers for Ocean Observations at Mepco Schlenk Engineering College, 13-14 March 2023.

Dr.G.Dharani

- Delivered a lecture Marine Microbiome under Climate Change in the International Conference on Antimicrobial Resistance & Microbiome Under Changing Climate (ARMCC 2022) DBT-NERC-funded AMRWATCH organized by Pondicherry University October 2022.
- Delivered a talk in the 4th International Seaweed Conference and Expo 2023 organized by Indian Chamber of Commerce in association with CSIR - Central Salt and Marine Chemical Research, Ahmadabad, January 2023.
- Delivered a lecture on Multiomic for healthcare ina Symposium on acceleration biology 2023 discovery to deliver organized by Bioinformatic group Centre for Development of Advance Computing, Pune, February 2023.
- Delivered a lecture in National Conference on conservation and sustainable use of marine resources and national science day celebration Integrated approach in science and Technology for sustainable Future organized by Academy of Maritime Education and Training, Chennai March 2022.
- Delivered a lecture on NIOT's contribution to open sea cage culture in Two days training program on Initiation of DPR preparation of high value infrastructure projects under FIDY and PMMSY for the coastal region state & union territories, organized by NFDB, Hyderabad, June 2022.
- Delivered a lecture in Symposium on Biological Diversity – National Perspective Biodiversity Crises, Concerns and mitigation approaches during April 2022 organized by Department of biotechnology Alagappa University and Babha Atomic Research Center.

Shri M. Arul Muthiah

- Delivered a lecture titled "Indian Tsunami Buoy Programme" at a Seminar organized by University of Madras on 3rd November 2022.

Dr. Dilip Kumar Jha

- Delivered a lecture on "Sustainable Aquaculture Practices", SAP-2022 at Justice Basheer Ahmed Sayeed College for Women (Autonomous), Chennai, on 11th May 2022.
- Delivered a lecture on "Satellite Remote Sensing-Ocean Color-Data Processing and Application" at Centre for Remote Sensing and Geoinformatics, Col. Dr. Jeppiaar Research Park, Sathyabama Institute of Science and Technology, Chennai on 25th January 2022.
- Delivered a lecture on "Mariculture in Indian Sea: A Geospatial Approach" as part of the Endowment Lecture series at Department of Zoology, Madras Christian College, East Tambaram on 31stMarch 2023.

Dr. S.Sundararajan

- Delivered a talk on "Bio-Geochemical process in the major Estuaries of Indian coastal area" in School of Energy, Environment, and Natural Resources, Madurai Kamaraj University onNovember 16, 2022.
- Delivered a talk on "Heavy metal pollution and its impact in the coastal and estuarine waters" at PSG College of Arts and Science, Coimbatore.

Dr. Prince Prakash Jebakumar

- Delivered a radio talk on Ocean conservation and Technology on National Maritime Day on 5th April 2023 at Pudhugai FM 91.2 MHz.
- Delivered an invited talk on "Marine plankton conservation by adopting eco-friendly technology for climate change mitigation" at the 12th National Conference on Natural Sciences, organized by Bose Science Society & Tamil Nadu Scientific Research Organization on 28th February 2023 at Pushkaram College of Agriculture Sciences, Pudukkottai, Tamil Nadu.
- Delivered an invited talk on "Redefining estuarine ecosystem multifunctionality through engineering intervention" at the International Conference on Multifunctional Materials and Radiation Measurements (ICMMRM 23), organized by SSN College of Engineering, Society For Radiation Research (SRR), Mumbai&IndianSpectrophysics Association (ISPA), Chennai from 27 to 28th January 2023 at Department of Physics, Sri Sivasubramaniya Nadar College of Engineering, Chennai.

Dr. K. Jossia Joseph

- Delivered a talk titled 'Invest in the Earth for a brighter Future' to the college students of the Agni College of Technology, OMR, Chennai as part of the Earth Day celebration on 22nd April 2022.
- Delivered a talk titled 'Revitalization: Collective Action for the Ocean' is delivered to the students of the Jeppiaar Engineering College, OMR, Chennai as part of the World Ocean Day celebration on 8th June 2022.

Shri. S. Ramasundaram

- As Chief Guest to inaugurate the National Level Technical Symposium ELEXRIEG 22K and Mini Project Expo 22 and to deliver the inaugural address in M N M Jain College of Engineering, Chennai, on 31st May 2022.

Shri B. Kesava Kumar

- Delivered a lecture titled Ocean Observing System and Autonomous Underwater Vehicles at a Seminar organized by the Dhaanish Ahmed College of Engineering on 8th October 2022.

Shri R Sundar

- As a Keynote Speaker delivered a lecture on "Emerging technology on Ocean Observations" during ICCST Conference at Sairam Engineering College, Chennai, on 10th November 2022.

Dr.K.Anandasabari

- Delivered a technical talk on "Integrated approach towards sustainable coastal disasters mitigation in coastal zone of India" at National workshop on "Geospatial Technology for coastal Disaster studies and Management [GEO-CODISM]" organized by Department of Earth Sciences, Annamalai University, Annamalai Nagar, Chidambaram during 16th to 18th November 2022.

15. INTERNATIONAL COLLABORATION

- NIOT-MoES is the nodal agency for India at OES Ocean Energy Systems (OES) Technology Collaboration Program (TCP) under International Energy Agency (IEA). Subtasks on Ocean energy powered desalination and OTEC Economics led by NIOT have been taken up currently at OES. Dr. Purnima Jalihal holds the position of Vice-Chair in the OES cabinet, the first Indian to do so.
- For the better utilization of moored buoy data, collaborative studies are being undertaken with NOAA PMEL, University of Massachusetts, USA; IIT Madras, Indian Navy, NPOL – DRDO Cochin etc. Collaborative project underthe MoES on Arabian Sea studies 'EKAMSAT' is in progress. OOS staff participates in international forums representing India such as Joint WMO – IOC Data Buoy Cooperational Panel. OOS team provides operational support to the International NOAA-PMEL RAMA network in Indian seas. As part of the international OceanSITES program, deep sea sensors are mounted in the Bay of Bengal and in the Arabian Sea.

Deployment team of NPOL-DRDO Acoustic Array onboard Sagar Nidhi

- Also provided technical and operational support to DSM Group of NIOT& NIO, Goa (4 deep sea moorings in the CIOB); OA Group of NIOT (Integrated Ambient Noise Measurement system); INCOIS (Bio-Geo-Chemical sensors & drifters); NPOL–DRDO (deployment and retrieval of the Acoustic Array - Fiber Optic-Intrusion Detection system; NCCR (real time transmission of water quality data); IGCAR, Kalpakkam (moored buoy deployment for Environment assessment & Radiation monitoring in Kalpakkam coastal waters); and CGCRI, Kolkata (development of optical technology based Indigenous sensors for Buoy system).

- Collaborative studies on scaled down model for offshore platforms are underway with IIT-Bombay as part of the objectives under Deep Ocean Mission.

16. NATIONAL COLLABORATION

- Memorandum of Understanding (MoU) for "Providing Technical Guidance and Design & Drawing of Climate Resilient Coastal Protection Measures for the State of Odisha" between Secretary, Department of WaterResources, Government of Odisha and Director, National Institute of Ocean Technology (NIOT), Chennai. The scope of this MoU shall cover but not limited to:

  a. Design & Drawing of site-specific climate resilient coastal protection structures and saline embankments based on the long-term shoreline change analysis, numerical model studies, considering the extreme events such as tropical cyclones and storm surges.

  b. Provide immediate mitigation measures in case of emergency situations.

  c. Post implementation monitoring and Performance evaluation studies

  d. Onsite visit to vulnerable locations before, during and after the implementation of remedial measures as and when required; and.

  e. Knowledge transfer in the field of coastal engineering in the form of training programs and workshops

  Under the aegis of this MoU two projects have been taken up by NIOT.

Signing of MoU by Director, National Institute of Ocean Technology, MoES, Government of India and Secretary, Water Resources Department, Government of Odisha in the presence of Minister of Water Resources, Government of Odisha

- Feasibility studies on fixed and floating platform for offshore wind turbine
- National Institute of Wind Energy, Ministry of New and Renewable Energy, Chennai.
- “Shipboard based nodule dewatering studies and prototype design development” - CISR-IMMT.
- “Experimental and Simulation Studies on Breakage/Degradation Behaviour of Polymetallic Nodules during Vertical Transport Environment” - CISR-IMMT.
- “Development of electrical impedance tomography-based system for monitoring of solids inside pipeline used in ocean mining application” - CISR-IMMT/ NIT Durgapur.
- “Polymetallic nodules transfer and degradation studies in vertical transport through a rigid and flexible pipe” - IITM/NIT Trichy.
- “Development of a ship-surface floater model for deep sea mining operations in open sea conditions” – IITM.
- “Investigation of juncture flow dynamics of deep-sea mining crawler” - IITM.
- “Coupled hydrodynamics of a deep-sea mining vessel with marine riser” - IITM.
- “EIA studies” - NIOT, Goa.
- “Manned submersible Simulator” - IIT Madras.
- “Homing docking and Sensor fusion for underwater vehicles” - CMERI, Durgapur.

17. MEMBER OF COMMITTEES

Dr.G.A.Ramadass

- Member of IEEE OES India Chapter (Founding Secretary)
- Life Member – Ocean Society of India
- Member 31st International Ocean Council (IOCINDIO)
- Member of Indian delegation to International Seabed Authority
- Member of India-Norway Task Force for Blue Economy
- Executive Committee Delegate for International Energy Agency-Ocean Energy Systems (IEA-OES)
- Member of National Decade Coordination Committee (NDCC) - Decade for Ocean Science
- Member of Naval Research Board
- Member of Standing Committee on Oceanography & Meteorology (SC-O&M)
- Member of Research Council of Tamilnadu Dr J Jayalalitha Fisheries University
- Member of Review committees of NSTL & CVRDE of DRDO
- Member of National Gas Hydrate Program

Dr. Purnima Jalihal

- Chairperson, Expert Committee- Biotechnology Career Advancement and Reorientation Program (BioCARe), since April 2022.
- Member, Technical Expert Committee on "Energy, Environment and Forest Biotechnology", Dept of Biotechnology, since April 2022.
- Member, School Board of Allied Studies, IMU, since March 2022.
- Member, Expert Committee to review 4rd Tranche FTT-FTC Projects (2022-2024) under Ecology, Environment, Earth, Ocean Sciences and Water (E3OW) Theme, CSIR, since March 2022
- Member, Technical Unit for Technology Screening for Jal Jeevan Mission, Constituted by Principal Scientific Adviser, Govt. of India, since Feb 2020 (continuing).

Dr. D. Rajasekhar

- Technical Member representing India in International Research Ship Operators [IRSO] forum.
- Technical Expert Member of Shipbuilding & Marine Engineering and Safety Aids Sectional Committees TED 17 & 19 under Bureau of Indian Standards [BIS].
- Member Secretary Joint Scientific & Technical Advisory Committee [JSTAC].
- Technical Expert Member of Inter agency Committee for Recovery Operations [ICRO] w.r.to safe recovery of the crew module of "Gaganyaan" an Indian crewed orbital spacecraft of the Indian Human Spaceflight Programme of ISRO.

- An Expert Member in the National Committee towards the preparation of Indian proposals for naming underwater features in the maritime areas of Indian interest and submission to the GEBCO Sub-Committee on Undersea Features Names (SCUFN).
- An Expert Member in CGSC [Capital Goods Sector Skill Council] Technical Expert Committee under National Skill Development Corporation (NSDC), Ministry of Skills Development and Entrepreneurship.
- An Expert Member of the Peer Review Committee (PRC) for Project of NARS "New Acoustic Research Ship" of NPOL, Kochi.
- An Expert Member of the Special Committee constituted by the Government of Tamil Nadu, provided strategic technical solutions for setting up the 'Maritime Heritage Museum' with the decommissioned Submarine INS Vagli planned by the Tamil Nadu government in the tourist town of Mamallapuram.
- An Expert Member of Task Force Committee (TFC) to finalize the tender documents for Total Management of MoES Vessels, contributed towards preparation & finalization of EoI& RFP documents.
- An Expert committee member for appointing design consultant and tender document preparation for the acquisition of new Polar Research Vessel & other new Research Vessels being acquired by NCPOR/MoES. Director NCPOR specially appreciated my efforts.
- An Expert Member for acquisition of Polar Research Vessel and Three new Research Vessels for NCPOR/MoES.
- An Expert member in CGSC [Capital Goods Sector Skill Council] Technical Expert Committee under National Skill Development Corporation (NSDC), Ministry of Skills Development and Entrepreneurship.
- An Expert member constituted of the Special Task Force Committee by DG Shipping on the fixation of port limits, provided inputs considering scientific interests such as shallow water survey, equipment trials in shallow waters and etc.

Dr. Dhilsha Rajapan

- Life member, Acoustic society of India
- Life member, Magnetic society of India
- Doctoral Committee member, Vellore Institute of Technology, (VIT) Vellore
- Doctoral Committee member, Anna University, Chennai
- Doctoral Committee member, SRM University, Chennai
- Committee member for the review of monographs published by DESIDOC, Defense Science Publications, Delhi
- Reviewer for OCEANS 2020 and International peer reviewed journals Acoustical Society of America (JASA), Measurements (Elsevier).

Dr.G.Latha

- Member of the Working Group on Data Management, International Quiet Ocean Experiment (IQOE), SCOR, USA.
- Member, Naval Research Board-Ocean Environmental Panel, DRDO, GoI
- Member, Doctoral Committee, Anna University.
- Member, Board of Studies and Doctoral Committee, Vellore Institute of Technology.

Dr. Basanta Kumar Jena

- Ocean Society of India (OSI) 2020-22, Secretary Chennai Chapter (2011-2020)
- Member of the management committee of the International Association for Coastal Reservoir Research (IACRR), 2020-2023
- Scientific Expert member for Eastern Dredging Associations (EADA), and World Organization of Dredging Associations (WODA) working group on Reservoir Dredging 2020-2023.
- Member of Coastal Protection and Development Advisory Committee (CPDAC), Coastal Management Directorate, CWC, New Delhi.
- Member of Marine Geology and Exploration and Coastal Geoscience, Geological Survey of India, GoI, Ministry of Mines, Mangaluru.
- Member of Regional Coordination Committee (R. C. C) of the Deltaic Regional Centre, National Institute of Hydrology, Kakinada,
- Member of National Coastal Zone Management Authorities (NCZMA), MoEF&CC, New Delhi.

Dr. Vijaya Ravichandran

- Member of the Environmental Appraisal Committee (EAC) for Nuclear, Defense Projects, Ministry of Environment and Forests (MoEF) GOI – Ended July 2022
- Member of Joint Committee formed by Hon'ble National Green Tribunal (NGT) to ascertain the damage caused by "Glass furnace pipe bursts at Titanium Factory in Thiruvananathapuram, oil leaked to sea" incident
- Member of Joint Committee formed by Hon'ble National Green Tribunal (NGT)'challenging the Environmental Clearance (EC) granted for the purpose of establishment of fishing harbour in Alamparaikuppam Village, Chengalpattu District and another harbour in Azhagankuppam Village, Villupuram District
- Chairperson of the Internal Complaints Committee for prevention of sexual harassment of women, National Institute of Wind energy (NIWE – MNRE)

Dr. S.V. S Phani Kumar

- Member of the Electro Technical Division Committee on Wind Turbines for BIS, ETD 42.

Dr. S.Ramesh

- Member, Legal and Technical Commission, International Seabed Authority, Jamaica
- Life Member, Ocean Society of India.
- Executive Council Member, Tamil Nadu Geologists Association.

Cdr. Gopkumar Kuttikrishnan

- Fellow of Institution of Engineers (India) (Marine Engineering) and Member of Institute of Marine Engineers, India.
- Member – Experts Appraisal Committee (EAC) for projects for Nuclear, Defence under MOEF&CC and other strategic projects

Dr. N. Vedachalam

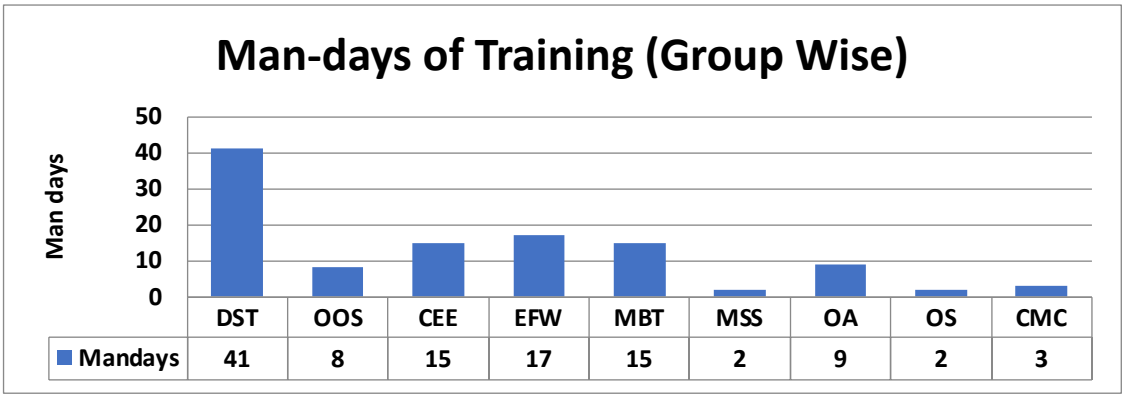
- Member, Marine Technology Society
- Member, Society for Underwater Technology
- Member, International Society of Offshore and Polar Engineers
- Member, IEEE OES
- Member, Naval Research Board

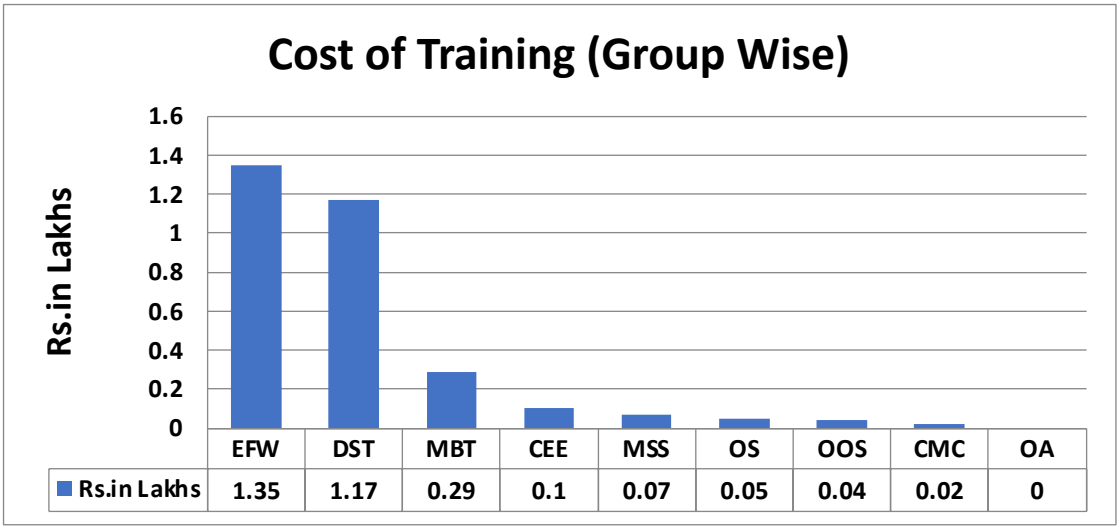
18. HUMAN RESOURCE DEVELOPMENT

The section organizes training courses in the areas of engineering, software, project management, personality development, product trainings etc. Besides the external training courses, efforts are also made to conduct extra mural lectures by eminent personalities in the other fields which are beneficial for the employees.

The department also provide both short term (4 weeks to 6 months) and long term (one year or so) project training to students pursuing M.Tech or their equivalent degree programmes, at different educational institutions spread over the country related to ocean technology to fulfill their academic degree requirements. The project topics are ensured to bring value addition to NIOT activities from the student community. Around 51 students completed the project work in various departments of NIOT. About 134 students did their short term internships (minimum 2 weeks maximum 4 weeks) and around 36 students did their implant training (minimum 5 days maximum 2 weeks) during the college summer and winter vacation.

With regards to the staff external training, the section has coordinated trainings cumulating about 330 man-days costing about Rs.5.2 Lakhs. The section-wise break up is shown in the following charts. The table with the technical training details is also presented.





Training Undergone by NIOT Scientists and Technical Staff				
S.No.	**Name of the Staff**	**Training/ Conference/ Workshop**	**Place**	**Period**
1.	Dr. G Venkatesan Scientist-G	Conference on Green Hydrogen in India	Organized by India Infrastructure Publishing, New Delhi	11.04.2022 To 12.04.2022 (2 days)
2	Mr. S. Srinivasa Rao, Scientist - D			
3	Mr.R.Ramesh Scientist-E	Workshop on Advances in statistical data analysis and modelling (WASDAM 2022	Online	25.07.2022 to 27.07.2022 (3 days)
4	Mrs.V.Bala Naga Jyothi Scientist-E			
5	Mr.V.Doss Prakash Scientist-D			
6	Mr. K.Prabhakaran Scientist-D			
7	Mr. A.A.Gnanaraj Scientist-E	A Refresher Course on Ocean Dredging and Mining	Organized by IIT Madras, Chennai Hybrid mode.	18.07.2022 to 22.07.2022 (5 days)
8	Mrs.K.Amudha Scientist-E			
9	Mr.A.S.Kiran Scientist-D			
10	Mr.S.Ramkumar Scientist-B			
11	Mr.S Rajesh Scientist-E			
12	Mr. R.Sundar Scientist-D	Workshop on Let us Practice LaTeX	Anna University, Chennai	1.9.2022 to 2.9.2022 (2 days)
13	Mr. K. Thirumurugan Scientist-D			
14	Mr. C Janarthanan Scientist-E			
15	Mr. G.Velu Technician,Grade-A	Annual Hypack Training, Hypack India 2022	Organized by ASB Systems at Goa	22.08.2022 to 24.08.2022 (3 days)
16	Dr. K. Jossia Joseph Scientist-E	Seminar on 'Impact of climate change on oceans, Naval Assets and operations'	Southern Naval Command, Kochi	28.09.2022 (1 day)
17	Mrs.Anulekha Majumdar Scientist-C	RENEW 22 Hybrid Conference	Online	08.11.2022 to 10.11.2022 (3 days)

18	Mr.Hemanth Kumar Meena Scientist-B	Construction Materials and Quality Control for Concrete Hydraulic Structures.	Central Soil and Materials Research Station, New Delhi	14.09.2022 to 15.09.2022 (2 days)
19	Ms.Femi Anna Thomas Pro.Sci-II	4thIBSE International Symposium on "Microbiomes in Environment, Space and Human Health"	Centre for Integrative Biology and systems Medicine (IBSE), IIT Madras	31.10.2022 to 02.11.2022 (3 days)
20	Mrs. B Karpaga Raja Sundari Project Sci-II			
21	Mr. R Vijaya Raghavan Project Sci-II			
22	Mr. Aron Santhosh Kumar Project Scientist-I	Seaweed India 2022, National Centre for Sustainable Coastal Management	Anna University, Chennai	28.09.2022 to 29.09.2022 (2 days)
23	Dr.M P Sudhakar Project Scientist-II			
24	Shri R Sundar, Scientist D	Ocean Best Practices System (OBPS) Workshop VI	Online	5th-19th, October 2022.
25	Shri R Sundar, Scientist D	First DBCP Mediterranean Training Workshop on Ocean Observations and Data Applications	Online	9th-11th November 2022.
26	Dr. S B Pranesh Scientist-E	Public Procurement (Basic), Arun Jaitley	National Institute of Financial Management, Faridabad.	14.11.2022 To 19.11.2022 (6 days)
27	Mr. G Harikrishnan Scientist-E			
28	Mr. S Srinivasa Rao Scientist- D	International Hydrogen & Fuel Cell Conference (IHFC 2022)	Hotel The Lalit, Barakhamba Road, New Delhi.	04.12.2022 to 06.12.2022 (3 days)
29	Mr. V Samson Packiaraj Raphael Scientist- E			
30	Mr. Sathyam Kumar, Project Scientist-I			
31	Mr.A Thirunavukkarasu Scientific Officer-I	2nd International Conference on Materials, Design and Manufacturing Process(ICMDM) 2023	CEG Campus, Anna University, Chennai	23.02.2023 to 25.02.2023 (3 days)

32	Dr. M P Sudhakar Project Scientist-II	4th edition of "India International Seaweed Expo and summit 2023 (IISES)" Esri India User Conference	Ahmedabad Management Association (AMA), Ahmedabad Organized by Esri, New Delhi	18.01.2023 (1 day)
33	Mr.Arun Siddharth R Project Scientist-I			
34	Mr.M Elavarasan Project Scientist-I			
35	Mr.Ashish Kumar Singh Project Scientist-1			
36	Mr. R.Sundar, Scientist E	8th India International Science Festival (IISF)	Maulana Azad National Institute of Technology (MANIT), Bhopal	21-24th January 2023

Extra Mural Lectures Delivered by Eminent Personalities

Shri. K. Ganesh, Senior Consultant (F&A), delivered a lecture on **"Service Rules"** on 15th June 2022.

M/s. Birns, USA, conducted a technical presentation on Penetrators on 01st July 2022

Dr. S.V. Raghurama Rao, Professor in Aerospace department in Indian Institute of Science, Bangalore, delivered a technical talk on **"Computational Fluid Dynamics"** on 05th July 2022.

Orientation Programme for Project Scientists (2022 batch) by each departments of National Institute of Ocean Technology was conducted on 26th October – 11th November 2022.

The **Capacity Building Commission (CBC)** of Government of India in association with the Office of PSA has set up a Capacity Building Cell which coordinates with S&T Ministries and Departments of Government of India to develop human and institutional capabilities to deliver on national priorities, was conducted by **Ministry of Earth Sciences** on 10th January 2023.

M/s.Fosroc Chemicals India Private Limited conducted a presentation on usage of the admixtures, chemicals for new civil marine construction on 21st February 2023.

S.No	Date	Name of the College	No. of students
1	08.04.22	Prince Shri Venkateswara Padmavathy Engineering College	60
2	19.04.22	IIT Madras	200
3	22.04.22	Rajalakshmi Engineering College	100
4	27.04.22	Anna University	40
5	29.04.22	Sri Sairam Engineering College	60
6	06.05.22	Sri Sairam Engineering College	50
7	13.05.22	Rajalakshmi Engineering College	100
8	20.05.22	RMD Engineering College	90
9	20.05.22	Anna University	66
10	27.05.22	RMD Engineering College	90
11	03.06.22	MNM Jain College	65
12	17.06.22	Loyola ICAM College	122
13	01.07.22	Jerusalem College of Engineering	105
14	08.07.22	Jerusalem College of Engineering	107
15	15.07.22	Jerusalem College of Engineering	98
16	12.08.22	GRT Institute of Engineering & Technology	53
17	18.08.22	GRT Institute of Engineering & Technology	47
18	18.08.22	VIT Chennai	70
19	25.08.22	Institute of Energy Studies, Anna University	21
20	26.08.22	St. Joseph's College of Engineering	88
21	02.09.22	Rajalakshmi Engineering College	104
22	09.09.22	Rajalakshmi Engineering College	104
23	16.09.22	Prince Shri Venkateswara Padmavathy Engineering College	60
24	16.09.22	VIT Chennai	70
25	19.09.22	Meenakshi Sundararajan College	55
26	21.09.22	Vivekananda Arts and Science College	55
27	23.09.22	SRM Engineering College	55
28	23.09.22	New Prince Shri Bhavani College of Engineering	34
29	30.09.22	SRM Engineering College	55
30	30.09.22	Meenakshi Sundararajan College	68
31	07.10.22	RMD Engineering College	90
32	07.10.22	Easwari Engineering College	62
33	12.10.22	Alagappa University	28
34	14.10.22	RMD Engineering College	90
35	21.10.22	RMK College of Engineering and Technology	80
36	28.10.22	Narayana Engineering College	84
37	04.11.22	RMK College of Engineering and Technology	55
38	18.11.22	Velammal Engineering College	55
39	18.11.22	Sairam Engineering College	102
40	02.12.22	Sairam Engineering College	100

S.No	Date	Name of the College	No. of students
41	06.12.22	VIT Chennai	25
42	26.12.22	Meenakshi Sundararajan College	55
43	20.01.23	MGR Fisheries University	45
44	23.01.23	Mizoram University	24
45	03.02.23	VIT, Chennai	9
46	10.02.23	GRT Engineering College	55
47	17.02.23	MNM Jain &St.Josephs Institute of Technology	99
48	24.02.23	St.Josephs Institute of Technology / Prof Dhanapalan College of Engineering	183
49	28.02.23	SAN Academy Keelkattalai	192
50	28.02.23	Sri Chaithanya	381
51	01.03.23	Holy Sai International School	85
52	01.03.23	Govt. High School Pallikaranai	59
53	01.03.23	Peniel School	42
54	01.03.23	St.Joseph Higher Secondary School	45
55	03.03.22	Vel Tech Multitech Dr.Rangarajan Dr.Sakunthala Engineering College	83
56	10.03.23	Sri Sairam Engineering College	93
57	17.03.23	Vel Tech Multitech Dr.Rangarajan Dr.Sakunthala Engineering College	118
58	24.03.23	SRMIST & Dharmambal Govt Polytechnic	85
59	28.03.23	Loyola College	29
60	31.03.23	VIT, Chennai	70
		TOTAL	**4815**

19. ADMINISTRATION

The details of sanctioned strength and no. of posts filled in along with vacancies as on 31.3.2023 is furnished below:

(a) Sanctioned strength and men in position

Sl.No.	Category	Sanctioned strength	Filled in	Vacant
1	Director	1	1	---
2	Scientific (*)	116	89	27
3	Technical	81	67	14
4	Administrative (*)	26	21	5
5	Official Lang. Hindi	04	2	2
6	Multi- Tasking Staff	06	6	---
	Total	**234**	**186**	**48**

(*) Two incumbent holding lien in NIOT and one incumbent on deputation basis.

(b) Appointments : NIL

(c) Direct Recruitments :

1	Shri Anand Kishor (Mechanical) (Gen) Sci-D	Direct Recruitment	1/4/2022
2	Shri Shobharam Joshi (UR) Hindi Typist	Direct Recruitment	25/8/2022

(d) Promotions Under Modified Flexible Complementing Scheme :

Sl.No	Name	Post	With effect from
1	Shri M Selva Kumar	Scientist-E	1/7/2022
2	Shri T S Kumar	Scientist-C	1/7/2022
3	Shri Krupa Ratnam	Scientist-C	1/7/2022
4	Dr Dilip Kumar Jha	Scientist-C	1/7/2022
5	Shri S Ragumaran	Scientist-C	1/7/2022
6	Dr Raju Abraham	Scientist-G	1/1/2023
7	Shri V Suseentharan	Scientist-F	1/1/2023
9	Shri P Murugesh	Scientist-E	1/1/2023
10	Shri S Srinivasa Rao	Scientist-E	1/1/2023
11	Shri R Sundar	Scientist-E	1/1/2023
12	Shri Ashwani Vishwanath	Scientist-E	1/1/2023
13	Shri B Kesava Kumar	Scientist-E	1/1/2023
14	Smt Shyamala Varthini D	Scientist-E	1/1/2023
15	Smt. Anulekha Majumder	Scientist-D	1/1/2023
16	Shri Anand Kishor	Scientist-D	1/1/2023
17	Shri Biswajit Haldar	Scientist-D	1/1/2023
18	Shri Hemant Kumar Meena	Scientist-C	1/1/2023
19	Smt. Rosmy Cherian	Scientist-C	1/1/2023

(e) Upgradation : NIL

(f) Re-designation : NIL

(g) Superannuation : NIL

Sl.No	Name	Post	Date of superannuation
1	Shri Tejavath Nagesh	Technician - Grade A	10/6/2022
2	Ms Sonitha S Saraf	Junior Translation Officer	1/8/2022 (technically resigned)

(i) Ph.D.

Dr N R Ramesh, Sci-F

Dr P Muthuvel, Sci-F

Dr R Srinivasan, Sci-F

Dr (Smt) A Malarkodi, Sci-E

Dr V Samson Packiaraj Raphael, Sci-E

(j) Summary of Audit Observation

S.No.	Year	No. of Paras / PA reports on which ATNs have been submitted to PAC after vetting by Audit	Details of the Paras / PA reports on which ATNs are pending		
			No. of ATNs not sent by the Ministry even for the first time	No. of ATNs sent but returned with observations and Audit is awaiting their resubmission by the Ministry	No. of ATNs which have been finally vetted by audit but have not been submitted by the Ministry to PAC
1	2022	-	-	-	-

(k) Matters Relating to Persons with Disabilities

S.No.	Name of the Ministry / Department: **National Institute of Ocean Technology, Chennai, Ministry of Earth Sciences**	
1	Various activities and the policy decisions taken for implementation of the RPwD ACT, 2016 during Financial Year 2022-2023	The reservation applicable in recruitment of post as provided under the Persons with disability Act, 2016 has been implemented in NIOT. The accessibility to buildings for persons with disabilities have been provided as per the requirements of the Act.
2	Information about the total budget provision of the Ministry / Department	No separate budget allocation

3	Allocation under various schemes for the benefit of persons with disabilities, the amount released and the amount utilized.	No specific scheme sanctioned by the Ministry of Earth Sciences specifically for the benefit of persons with disabilities other than meeting the statutory obligations under Persons with disability Act, 2016.
4	The number of beneficiaries with disabilities and their percentage in relation to the total number of beneficiaries	does not arise.
5	Whether a separate chapter in the Annual Report of the Ministry / Department outlining the policy decisions and activities undertaken for the benefit of the Persons with Disabilities has been included? If not, when does the Ministry / Department proposes to do so?	It is included.
6	A copy of the Annual Report for the year 2022-2023 indicating policy decisions and the activities undertaken by the Ministry / Department for the benefits of persons with disabilities.	The Annual Report for the year 2022-23 is under draft version only and yet to be completed.

(l) Deputation Abroad

S. No.	Name of the official	Designation	Place of visit	From	To	Purpose
1	Shri A.N.Subramanian	Sci-F	Spain	21/Jun/22	27/Jun/22	To witness the batteries Factory Acceptance Test (FAT) at M/s. Ictineu's Test Facility
2	Shri R.Ramesh	Sci-E				
3	Shri S.Krishna Mohan	Joint Manager				
4	Shri S,Elangovan	Sci. Officer Grade-I				
5	Dr.S.Ramesh	Sci-G	Kingston, Jamaica	4/Jul/22	15/Jul/22	To attend the second part of the 27th session of LTC as a nominated Member for the Legal and Technical Commission (LTC) of International Seabed Authority (ISA)
6	Dr.Dhilsha Rajapan	Sci-G	Brest, France	26/Sep/22	30/Sep/22	NIOT-IFREMER session as part of SeaTech Week 2022 conference
7	Dr. D.Sathianarayanan	Sci-F				
8	Shri A.S.Kiran	Sci-E				
9	Dr. G.A.Ramadass	Director				
10	Shri M.Palaniappan	Sci-F				

S. No.	Name of the official	Designation	Place of visit	From	To	Purpose
11	Shri Gopkumar Kuttikrishnan	Sci-G	Florida, USA	29/Sep/22	6/Oct/22	To attend the ISA-2022 contractors meeting and UMC 2022
12	Shri. A.Thirunavakkurasu	Sci.Officer Grade-I	Arctic	3/Oct/22	7/Oct/22	To participate in ANMS and CAATEX program
13	Shri G.Raguraman	Sci.Officer Grade-II				
14	Dr.Purnima Jalihal	Sci-G	Spain	17/Oct/22	20/Oct/22	To attend the 47th ExCo meeting & ICOE and meeting on Dev. on Ocean Energy & IEA-OES white paper on OTEC
15	Dr.Tata Sudhakar	Sci-G	WMO Head-quarters, Geneva, Switzer-land	1/Nov/22	4/Nov/22	To attend the 38th session of the Joint WMO-IOC Data Buoy Cooperation Panel (DBCP-38)
16	Dr. G.A.Ramadass	Director	Kingston, Jamaica	1/Nov/22	11/Nov/22	To attend the 3rd part council meeting of the 27th session of the International Seabed Authority (ISBA) meeting
17	Shri Gopkumar kuttikrishnan	Sci-G	UK, Norway, Nether-lands, Belgium	14/Nov/22	23/Nov/22	To explore the latest technologies, devel-opments abroad and implementation in NIOT projects
18	Dr.P.Muthuvel	Sci-F				
19	Shri S.Rajesh	Sci-E				
20	Shri A.A.Gnanaraj	Sci-E				
21	Shri C.Janarthanan	Sci-E				
22	Dr. G.A.Ramadass	Director	Kingston, Jamaica	16/Mar/23	31/Mar/23	To attend the first part council meeting of the 28th session of the ISBA meeting
23	Dr.S.Ramesh	Sci-G	Kingston, Jamaica	7/Mar/23	15/Mar/23	To attend the first part of the 28th session of LTC as a nominated member LTC of ISA
24	Dr.Tamshuk Chowdhury	Sci-E	Sharjah, UAE	20/Mar/23	23/Mar/23	To witness the progress of realiza-tion and testing of systems of Human Safety and Support System (HSSS) of manned submers-ible
25	Shri V.Doss Prakash	Sci-D				
26	Smt. R.Rathi Kumari	Asst. Manager				

20. RIGHT TO INFORMATION

The Right to Information Act 2005 came into force for its enactment from 12th October 2005 to promote transparency and accountability in the working of every public authority in India.

Right to Information Annual Return 2022– 2023

Ministry / Department / Organization : National Institute of Ocean Technology, Chennai

Ministry of Earth Sciences

Year : 2022–2023 (April 2022 to March 2023)

Progress in 2022 – 2023						
	Opening Balance as on 01.04.2022	**No. of applications received as transfer from other Pas u/s 6(3)**	**Received during the Year (including cases transferred to other Public Authority)**	**No. of cases transferred to other Public Authorities**	**Decisions where requests / appeals rejected**	**Decisions where requests / appeals accepted**
Requests	3	14	39	0	0	52
First Appeals	1	0	0	0	0	1

No. of Cases where disciplinary action taken against any Officer	0

No. of CAPIOs designated	**No. of CPIOs designated**	**No. of AAS designated**
0	1	1

No. of times various provisions were invoked while rejecting requests													
Relevant Section of RTI Act 2005													
Section 8 (1)										**Sections**			
a	b	c	d	e	f	g	h	i	j	9	11	24	Others
0	0	0	0	0	0	0	0	0	0	0	0	0	0

Amount of Charges Collected (in Rs.)		
Registration Fee Amount	**Additional Fee & Any other charges**	**Penalties Amount**
330	-	-

RTI Annual Return Information System (2022 - 2023)	
National Institute of Ocean Technology, Chennai Ministry of Earth Sciences	
Organization Status Attached Office	Autonomous Body under Ministry of Earth Sciences, Government of India
Name of Organization (up to 100 characters)	National Institute of Ocean Technology
Nodal / Coordinating Officer Name	Prasad Vinayak Dudhgaonkar
Nodal / Coordinating Officer designation	Scientist - E
Contact Address	National Institute of Ocean Technology Velachery Tambaram Main Road, Pallikaranai, Chennai – 600 100.
State	Tamil Nadu
E-Mail Address	cpio@niot.res.in
Phone Number	044 – 6678 3358 extn.7091
Fax No.	044 – 6678 3335
Website address of Organization	www.niot.res.in

RTI Annual Return Information System (2022 – 2023)	
National Institute of Ocean Technology, Chennai Ministry of Earth Sciences	
Name of CPIO	Prasad Vinayak Dudhgaonkar
Gender	Male
Designation	Scientist – E
Address	National Institute of Ocean Technology, Velachery – Tambaram Main Road, Pallikaranai, Chennai.
Pin code	600 100.
Phone No.	044 – 6678 3358 extn.7091
Email	cpio@niot.res.in
Appellate Authority Name	Dr. G. A. Ramadass, Director, NIOT, Chennai

T.A.P. VARADAKUTTI & CO.,
Chartered Accountants,

Old No.50, New No 70, 53rd Street,
9th Avenue, Ashok Nagar, Chennai - 83
✆ Office : 2371 6658, 2489 0665
Mobile : 98410 48947
E-mail : tapvaradakuttiandco@gmail.com

Ref No.

Date :.....

Date: 25-08-2023

INDEPENDENT AUDITOR'S REPORT

Report on the Audit of the Financial Statements for the financial year ended 31.3.2023

Opinion

We have audited the financial statements of NATIONAL INSTITUTE OF OCEAN TECHNOLOGY (NIOT) Chennai which comprise the Balance Sheet as on 31"t March 2023 and the Statement of Income & Expenditure and Statement of Receipts and Payments account for the year then ended on that date and notes to the financial statements including the summary of significant accounting policies and other explanatory information. In our opinion and to the best of our information and according to the explanations given to us, the aforesaid standalone financial statements give the information required by the Act in the manner, so required and give a true and fair view in conformity with the accounting principles generally accepted in India, of the state of affairs of NIOT as at March 31st 2023 and excess of Expenditure over Income for the year ended on that date.

Basis of opinion

we conduct our audit in accordance with the standards on auditing (SAs) issued by The Institute of Chartered Accountants of India. Our responsibilities under those standards are further described in the auditor's responsibilities for the audit of the financial statements section of our report. We are independent of the entity in accordance with the code of Ethics issued by the Institute of Chartered Accountants of India together with the ethical requirements that are relevant to our audit of the financial statements and we have fulfilled our other ethical responsibilities in accordance with these requirements and the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

T.A.P. VARADAKUTTI & CO. CHENNAI 600 083. Chartered Accountants

Responsibility of Management for Standalone Financial Statements

The Management is responsible for the preparation and fair presentation of the financial statements that give a true and fair view of the financial position, Financial performance in accordance with the accounting principles generally accepted in India, This responsibility also includes maintenance of adequate accounting records for safeguarding of the assets of the entity and for preventing and detecting frauds and estimates that are reasonable and prudent, and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give a true and fair view and are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the entity's ability to continue as a going concern,disclosing,as applicable,matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the entity or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the entity's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

T.A.P. VARADAKUTTI & CO. CHENNAI 600 083. Chartered Accountants

Report on Other Legal and Regulatory Requirements

1. We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit.

2. In our opinion, proper books of accounts as required by the law have been kept by National Institute of Ocean Technology so far as it appears from our examination of those books.

3. The Balance Sheet, Statement of Income & Expenditure and Statement of Receipts & Payments dealt with by this report are in agreement with the Books of Account.

4. In our opinion, the Balance Sheet, Statement of Income & Expenditure and Statement of Receipts & Payments dealt with by this report are prepared in accordance with the applicable Accounting Standards issued by The Institute of Chartered Accountants of India.

For T.A.P. Varadakutti & Co
Chartered Accountants
FRN: 004511S

Partner
CA. T.A.P. Varadakutti
M.No: 015316
UDIN: 23015316BGWRQY6613

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

BALANCE SHEET AS AT 31ST MARCH 2023

(Amount in Rupees)

LIABILITIES	Schedule	31.03.2023	31.03.2022
CAPITAL FUND	1	5,01,54,73,482	4,12,85,40,747
RESERVES AND SURPLUS	2	67,00,24,450	64,68,03,718
EARMARKED / SPONSORED PROJECT FUNDS	3	11,93,65,139	1,07,03,01,392
CURRENT LIABILITIES AND PROVISIONS	4	78,81,57,387	1,32,11,98,341
TOTAL		**6,59,30,20,457**	**7,16,68,44,198**
ASSETS			
FIXED ASSETS	5	4,84,92,83,657	4,16,80,19,745
INVESTMENTS - OTHERS	6	1,15,80,18,787	1,29,07,84,159
CURRENT ASSETS, LOANS, ADVANCES, ETC.	7	58,57,18,013	1,70,80,40,294
TOTAL		**6,59,30,20,457**	**7,16,68,44,198**
Significant Accounting Policies	13		
Contingent Liabilities and Notes to Accounts	14		

For National Institute of Ocean Technology, Chennai

As per our Report of even date
For T.A.P. VARADAKUTTI & Co
Chartered Accountants
FIRM REGN.NO.004511S

Date: August 25, 2023
Place: Chennai 600 100

DIRECTOR

PARTNER
CA T.A.P.VARADAKUTTI
Memb No: 015316
UDIN: 23015316BGWRQY6617

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDING 31ST MARCH 2023

(Amount in Rupees)

INCOME	Schedule	2022-23	2021-22
Scientific and Technical Consultancy Services		6,72,08,604	9,92,61,729
Other receipts		1,00,000	2,75,000
Grants-in-aid - Core Grant	8	45,80,00,000	42,40,00,000
Transferred from Core Grant (equivalent to depreciation charged during the year)		3,51,94,323	3,35,81,612
Interest Earned	9	67,84,132	81,21,336
Other Income	10	20,26,882	52,52,333
TOTAL (A)		**56,93,13,941**	**57,04,92,010**
EXPENDITURE			
Expenditure on Scientific and Technical Consultancy Services		5,78,37,759	7,68,08,699
Establishment Expenses	11	35,84,94,582	41,43,44,596
Administrative Expenses	12	11,40,04,868	8,13,26,463
Depreciation on assets created out of Core Grants		3,51,94,323	3,35,81,612
TOTAL (B)		**56,55,31,532**	**60,60,61,370**
Excess of income over expenditure (A-B)		37,82,409	-3,55,69,360
Appropriations			
1.Interest and other receipts earned and received during the Year under the programme "Core Grant" refundable to Ministry of Earth Sciences, Government of India transferred to Schedule 4 - Current Liabilities & Provisions (as per Schedule 9-10)		40,04,614	63,82,043
2.Balance of Excess of income over expenses on Scientific and Technical Consultancy Services transferred to Corpus Fund		93,70,845	2,24,53,030
3. Other Receipts		1,00,000	2,75,000
4.Interest Earned on Scientific & Technical Consultancy Services		48,06,400	69,91,626
Balance being excess of Expenditure over Income transferred to Schedule 1a - Core Capital Fund		-1,44,99,450	-7,16,71,059
		37,82,409	**-3,55,69,360**
Significant Accounting Policies	13		
Contingent Liabilities and Notes to Accounts	14		

Date: August 25, 2023
Place: Chennai 600 100

For National Institute of Ocean Technology, Chennai

DIRECTOR

As per our Report of even date
For T.A.P. VARADAKUTTI & Co.
Chartered Accountants
FIRM REGN.NO.004511S

PARTNER
CA T.A.P.VARADAKUTTI
Memb No:015316
UDIN: 23015316BGWRQY6613

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

(Amount in Rupees)

SCHEDULE 1 - CAPITAL FUND		31.03.23		31.03.22	
A	BALANCE AS AT THE BEGINNING OF THE YEAR	3,93,27,79,465		3,47,69,48,094	
	Add: Additions during the year	1,40,25,26,906		85,05,82,750	
	Less: Provision for Depreciation	48,09,00,398	4,85,44,05,973	39,47,51,379	3,93,27,79,465
B	CORE CAPITAL FUND		16,10,67,508		19,57,61,281
	BALANCE AT THE YEAR END (A+B)		**5,01,54,73,482**		**4,12,85,40,747**

Schedule -1

T.A.P. VARADAKUTTI & CO. Chartered Accountants CHENNAI 600 083.

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SUB-SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

(Amount in Rupees)

SUB-SCHEDULE -1A - CORE CAPITAL FUND		31.03.23	31.03.22
	Transferred from Capital Fund	19,57,61,281	29,60,13,952
	Add: Grant received during the year	1,50,00,000	50,00,000
	Add: Excess of Income over Expenditure	-	-
	Less: Excess of Expenditure over Income	1,44,99,450	7,16,71,059
	Less: Transferred to I&E A/C (Equivalent of depreciation claim during the year)	3,51,94,323	3,35,81,612
	BALANCE AT THE YEAR END (Transferred to Capital Fund)	**16,10,67,508**	**19,57,61,281**

Schedule -1A

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

(Amount in Rupees)

SCHEDULE 2 - RESERVES AND SURPLUS		31.03.23		31.03.22	
	Corpus Fund				
i.	**Reserves created out of Technical / Consultancy Projects**				
	As per last Balance sheet	62,27,92,111		57,01,87,380	
	Add:- Additions during the year	4,76,35,120		5,69,53,951	
	Less:- Transferred to Medical Reserve Fund	5,00,00,000			
	Less:- Deductions during the year	77,80,964	61,26,46,267	43,49,220	62,27,92,111
	Sub - Total		**61,26,46,267**		**62,27,92,111**
ii.	**Medical Reserve Fund**				
	As per last Balance sheet	-		-	
	Add:- Transferred from Corpus Fund	5,00,00,000		-	
	Add:- Subscriptions Received during the year	2,77,800		-	
	Add:- Interest Earned during the Year	7,05,952		-	
	Less:- Deductions during the year	-	5,09,83,752	-	-
	Sub - Total		**5,09,83,752**		-
iii.	**Scientific & Technical Consultancy Project Equipment Fund**				
	As per last Balance sheet	2,40,11,607		3,73,59,998	
	Add:- Additions during the year	11,72,995		18,85,301	
	Less:- Depreciation on the assets created	1,87,90,171	63,94,431	1,52,33,692	2,40,11,607
	Sub - Total		**63,94,431**		**2,40,11,607**
	GRAND TOTAL (i+ii+iii)		**67,00,24,450**		**64,68,03,718**

Schedule -2

T.A.P. VARADAKUTTI & Co. CHENNAI 600 083.

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

SPONSORED PROJECT FUNDS

Details / Grants pertaining to	Balance as on 1.4.2022	Add: Receipts			Less: Expenditure					Balance as on 31.03.23
		Grants Received	Other Receipts	Interest Earned and received	Expenditure Revenue	Project Equipment/WIP	Project Advances Earlier Year Adjustments	Interest, other receipts & unspent balance payable to MoES	Interest, other receipts & refund of unspent balance paid to MoES	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1. MoES PROJECTS										
A. SCHEME-Ocean Services, Modelling Application, Resources and Technology (O-SMART)										
Ocean Technology	58,62,71,358	-	2,16,845	85,66,938	17,87,11,769	31,52,06,001	14,25,03,904	87,83,783	4,87,00,000	-9,88,50,316
Ocean Observation Network - Moored Ocean Observation Network and HF Radar	8,95,39,717	24,97,00,000	17,179	13,70,700	25,62,25,049	2,19,85,617	-	13,87,879	-	6,10,29,052
Ocean Non-Living Resources - Geoscientific Studies of Exclusive Economic Zone	-2,69,43,956	5,36,00,000	742		5,25,56,668	60,48,090	-	742	-	-3,19,48,714
Operation & Maintenance of Research Vessels	-5,73,65,940	84,17,73,979	32,01,859	62,69,023	35,48,30,324	31,75,37,024	-	94,70,882	-	11,20,40,691
Seawater Quality Monitoring	1,34,464	20,100	-	3,226	88,782	-	-	3,226	-	65,782
B.SCHEME -DEEP OCEAN MISSION (DOM)										
Development of Technologies for Deep Sea Mining and Manned Submersible, Underwater Vehicles and Underwater Robotics	31,11,98,769	38,69,28,817	99,698	42,69,531	16,00,88,573	53,80,39,013	-	43,69,229	-	-
Technological innovation for exploration and conservation of deep sea biodiversity	9,49,96,111	-	-	13,41,030	43,17,869	47,29,923	3,50,00,000	13,41,030	-	5,09,48,319
Energy and freshwater from the Ocean	6,06,02,741	-	8,524	24,99,138	2,06,57,339	2,12,50,302	-	25,07,662	-	1,86,95,100
Advanced marine station for Ocean Biology	68,46,649	-	-	1,23,026	23,72,966	-	-	1,23,026	-	44,73,683
C.Information Technology and E-Governance activities	17,57,790	-	-	48,447	-	2,27,032	-	48,447	-	15,30,758
SUB-TOTAL - 1 (A TO D)	**1,06,70,37,702**	**1,53,20,22,896**	**35,44,847**	**2,44,91,059**	**1,02,98,49,338**	**1,22,50,23,002**	**17,75,03,904**	**2,80,35,906**	**4,87,00,000**	**11,79,84,355**
2. OTHER GOVERNMENT GRANTS										
National Post- Doctoral Fellowship	25,36,131	8,82,956	-	33,452	21,29,250	-	-	-	5,65,686	7,57,603
Protection of beach from sea erosion at selected locations along the Coast of Odisha	5,25,369	-	-	11,119	1,21,057	-	-	-	-	4,15,431
"Digital Poompuhar" network	2,02,190	-	-	5,560	-	-	-	-	-	2,07,750
SUB-TOTAL - 2	**32,63,690**	**8,82,956**	**-**	**50,131**	**22,50,307**	**-**	**-**	**-**	**5,65,686**	**13,80,784**
TOTAL-1+2	**1,07,03,01,392**	**1,53,29,05,852**	**35,44,847**	**2,45,41,190**	**1,03,20,99,645**	**1,22,50,23,002**	**17,75,03,904**	**2,80,35,906**	**4,92,65,686**	**11,93,65,139**
PREVIOUS YEAR	**-18,25,86,110**	**3,35,64,10,765**	**1,06,30,984**	**2,04,53,536**	**1,22,85,72,747**	**62,97,59,609**	**22,08,23,141**	**2,73,01,006**	**2,81,51,278**	**1,07,03,01,392**

Schedule-3

राष्ट्रीय समुद्र प्रौद्योगिकी संस्थान • रास प्रौ सं NIOT • National Institute of Ocean Technology

T.A.P. VARADAKUTTI & CO. CHENNAI 600 083. Chartered Accountants

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY · CHENNAI · NIOT

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

(Amount in Rupees)

SCHEDULE 4 - CURRENT LIABILITIES & PROVISIONS	31.03.23		31.03.22	
A. STATUTORY LIABILITIES				
Tax Dues	1,71,11,488		72,68,060	
CPF Contribution	68,45,652		69,29,700	
NPS Contribution	24,81,733	2,64,38,873	22,45,670	1,64,43,430
B.OTHER CURRENT LIABILITIES				
Pay & Allowances for the month of March 2023	2,86,30,503		3,40,71,927	
Outstanding Liabilities	3,05,12,730		49,23,77,508	
Interest & Other Receipts Refundable to MoES	2,81,16,210		2,73,01,006	
Earnest Money & Retention money	14,10,57,572		13,41,11,153	
NPS Subscription & Contribution - Legacy	3,25,11,190		3,43,59,844	
Interest and other receipts earned and received during the Year under the programme "Core Grant" refundable to MoES transferred to Schedule - 4 - Current Liabilities & Provisions (as per Schedule - 9-10 - Interest Earned & Other Income)	40,04,614	26,48,32,819	63,82,043	72,86,03,481
Project Advances *(Vide Sub-Schedule:B)*		49,68,85,695		57,61,51,430
TOTAL (A+B)		**78,81,57,387**		**1,32,11,98,341**

Schedule-4

राष्ट्रीय समुद्र प्रौद्योगिकी संस्थान • National Institute of Ocean Technology • रा स प्रौ सं NIOT

T.A.P. VARADAKUTTI & CO. ★ Chartered Accountants ★ CHENNAI 600 083.

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SUB-SCHEDULE:B FORMING PART OF SCHEDULE- 4 OF THE BALANCE SHEET AS AT 31ST MARCH 2023

Details / Grants Pertaining to	Balance as on 1.4.2022	Add: Receipts			Less: Expenditure				Balance as on 31.03.23
		Received & Receivable	TDS Receivables	Interest Earned/Other Receipts	Revenue	Capital/WIP	Project Advances Earlier year Adjustments	Transfer/ Adjustments	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
PROJECT ADVANCES									
Scientific and Technical Consultancy Services	12,50,18,605	10,07,25,256	27,53,828	-	2,87,69,030	11,72,995	-	76,44,130	19,09,11,534
On Deposit : Installation of 1 lakh litres per day capacity Seawater Low Temperature Thermal Desalination Plants at Agatti, Andrott, Minicoy, Amini, Kiltan & Chetlat Islands	45,11,32,825	-	-	2,16,70,047	3,10,54,521	13,57,74,190	-	-	30,59,74,161
TOTAL - B	**57,61,51,430**	**10,07,25,256**	**27,53,828**	**2,16,70,047**	**5,98,23,551**	**13,69,47,185**	**-**	**76,44,130**	**49,68,85,695**
PREVIOUS YEAR	**82,66,34,505**	**2,83,52,910**	**21,86,389**	**10,04,52,002**	**9,51,31,877**	**24,43,89,469**	**1,95,00,000**	**2,24,53,030**	**57,61,51,430**

Sub-Schedule: B

राष्ट्रीय समुद्र प्रौद्योगिकी संस्थान NIOT National Institute of Ocean Technology

T.A.P. VARADAKUTTI & Co. Chartered Accountants CHENNAI 600 083.

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY · CHENNAI · NIOT

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

SCHEDULE 5 - FIXED ASSETS

(Amount in Rupees)

S.No	DESCRIPTION	GROSS BLOCK					DEPRECIATION				Provision for loss / Unserviceable Assets				NET BLOCK	
		Cost/Valuation as on 01.04.22	Additions during the year	Project Advances Earlier Year Adjustments	Deletions	Cost/Valuation as on 31.03.23	Upto 01.04.22	Additions during the year	Deletion during the year	Total upto 31.03.23	Upto 01.04.22	Additions during the year	Deletion during the year	Total upto 31.03.23	As on 31.03.23	As on 31.03.22
A.	**FIXED ASSETS created out of MoES Grants**															
1	**Lands-Freehold**															
	NIOT Campus, Pallikaranai, Chennai	3,53,67,827	-	-	-	3,53,67,827	-	-	-	-	-	-		-	3,53,67,827	3,53,67,827
	Freehold Land -Dollygunj A&N Islands	37,29,070	-	-	-	37,29,070	-	-	-	-	-	-		-	37,29,070	37,29,070
	Seafront Facility - Land at Thirupathi District, Andhra Pradesh	14,48,77,059	-	-	-	14,48,77,059	-	-	-	-	-	-		-	14,48,77,059	14,48,77,059
2	**Buildings**	-		-		-	-	-		-	-	-		-	-	-
	Buildings & Infrastructure at NIOT Campus	55,17,21,153	-	-	-	55,17,21,153	41,71,53,692	2,77,52,760	-	44,49,06,452	-	-		-	10,68,14,701	13,45,67,461
	Buildings - Seafront Research Facility for NIOT @ Pamanji & Chittedu, Thirupathi District, Andhra Pradesh	11,38,53,782	-	-	-	11,38,53,782	56,92,689	1,08,36,109	-	1,65,28,798					9,73,24,984	10,81,61,093
	Building at ACOSTI, Port Blair	26,28,85,478	-	-	-	26,28,85,478	4,64,16,438	2,15,85,728	-	6,80,02,166	-	-		-	19,48,83,312	21,64,69,040
3	**Equipment**	-					-								-	-
	General Equipment	16,75,81,997	1,27,72,362	-	-	18,03,54,359	12,46,69,298	74,41,563	-	13,21,10,861	-	-		-	4,82,43,498	4,29,12,699
	Project Equipment under MoES Projects Grants	7,95,52,28,087	1,24,75,48,758	-	2,15,91,489	9,18,11,85,356	5,53,77,37,612	44,84,78,561	89,86,079	5,97,72,30,094	4,93,98,459	-	1,26,05,410	3,67,93,049	3,16,71,62,214	2,36,80,92,017
	TOTAL UNDER (A)	**9,23,52,44,453**	**1,26,03,21,120**	**-**	**2,15,91,489**	**10,47,39,74,084**	**6,13,16,69,729**	**51,60,94,721**	**89,86,079**	**6,63,87,78,371**	**4,93,98,459**	**-**	**1,26,05,410**	**3,67,93,049**	**3,79,84,02,665**	**3,05,41,76,265**
B	**Capital work in progress**	**56,09,65,404**	**17,06,15,428**	**-**	**63,50,55,440**	**9,65,25,392**	**-**	**-**	**-**	**-**	**-**	**-**		**-**	**9,65,25,392**	**56,09,65,404**
C	**Advances to Capital Projects**	**52,88,66,469**	**45,12,11,931**	**-**	**3,21,17,231**	**94,79,61,169**	**-**	**-**	**-**	**-**	**-**	**-**		**-**	**94,79,61,169**	**52,88,66,469**
D	**Fixed Assets created out of Scientific & Technical Consultancy Projects**	-					-								-	-
1	Scientific & Technical Equipment	16,40,70,806	11,72,995	-	-	16,52,43,801	14,00,59,199	1,87,90,171	-	15,88,49,370	-	-		-	63,94,431	2,40,11,607
	GRAND TOTAL (A+B+C+D)	**10,48,91,47,132**	**1,88,33,21,474**	**-**	**68,87,64,160**	**11,68,37,04,446**	**6,27,17,28,928**	**53,48,84,892**	**89,86,079**	**6,79,76,27,741**	**4,93,98,459**	**-**	**1,26,05,410**	**3,67,93,049**	**4,84,92,83,657**	**4,16,80,19,745**
	PREVIOUS YEAR	**9,63,32,78,195**	**1,00,82,66,822**	**22,08,23,141**	**37,32,21,026**	**10,48,91,47,132**	**5,82,83,14,952**	**44,35,66,682**	**1,52,706**	**6,27,17,28,928**	**4,93,98,459**	**-**	**-**	**4,93,98,459**	**4,16,80,19,745**	**3,75,55,64,784**

राष्ट्रीय समुद्र प्रौद्योगिकी संस्थान · राससौसं NIOT · National Institute of Ocean Technology

T.A.P. VARADAKUTTI & CO. · CHENNAI 600 083. · Chartered Accountants

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

(Amount in Rupees)

	SCHEDULE 6 - INVESTMENTS	31.03.23	31.03.22
a.	Funds received for rendering Scientific and Technical Consultancy Services	15,49,27,632	10,00,46,364
b.	Reserves Created out of Scientific & Technical Consultancy Services- Corpus Fund	57,76,01,926	60,32,43,681
c.	Deposits from other Agencies	42,54,89,229	58,74,94,114
	TOTAL	**1,15,80,18,787**	**1,29,07,84,159**

Break Up Details for the above:-		
Canara Bank	48,91,14,471	1,18,87,11,263
State Bank of India	66,89,04,316	10,20,72,896
TOTAL	**1,15,80,18,787**	**1,29,07,84,159**

Schedule-6

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2023

(Amount in Rupees)

SCHEDULE 7 - CURRENTS ASSETS, LOANS & ADVANCES	31.03.23	31.03.22
A. CURRENT ASSETS		
Balance with Banks in Savings Accounts	44,14,01,897	1,49,73,57,952
Bank Fixed Deposits (earmarked for Margin Money for LC Opened)	1,90,00,000	11,01,00,000
B. LOANS AND ADVANCES		
i Staff Advances		
Non-Interest bearing Advances to employees	39,51,757	8,10,100
Interest bearing Advances to employees	19,164	1,18,079
ii Advances and other amounts recoverable in cash or in kind for value to be received		
TDS Claimed and Refundable	1,81,96,940	2,06,00,002
TDS due but deferred	1,60,97,865	1,33,44,037
Prepaid Expenses	1,13,81,784	1,07,04,441
Project Advances	-	28,05,48,602
Deduct: Adjustments relating to earlier years	-	-28,05,48,602
Advance Payment to Suppliers	1,55,88,633	1,16,87,286
Other Receivables	1,44,28,309	1,22,50,543
iii Interest accrued but not due	4,56,51,664	3,10,67,855
TOTAL	**58,57,18,013**	**1,70,80,40,294**

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT AS ON 31ST MARCH 2023

(Amount in Rupees)

SCHEDULE 8 - GRANTS-IN-AID-CORE GRANT	2022-23		2021-22	
Grants-in-aid received from MoES - Manpower,Operational and Maintenance expenses of National Institute of Ocean Technology				
GIA - SALARY	34,80,00,000		32,10,00,000	
GIA - GENERAL	11,00,00,000		10,30,00,000	
GIA - CAPITAL	1,50,00,000	**47,30,00,000**	50,00,000	**42,90,00,000**
Less: Amount allocated for Capital Expenditure and transferred to Capital Fund				
General Equipment		**1,50,00,000**	50,00,000	**50,00,000**
TOTAL		**45,80,00,000**		**42,40,00,000**

Schedule-8

T.A.P. VARADAKUTTI & CO. CHENNAI 600 083. Chartered Accountants

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS ON 31ST MARCH 2023

(Amount in Rupees)

SCHEDULE 9 - INTEREST EARNED	2022-23	2021-22
On Savings Account	19,77,732	11,29,710
Interest Earned on Scientific & Technical Consultancy Services	48,06,400	69,91,626
TOTAL	**67,84,132**	**81,21,336**

Schedule-9

(Amount in Rupees)

SCHEDULE 10 - OTHER INCOME	2022-23	2021-22
Rent Received	8,64,701	2,90,162
Sundry Receipts	11,62,181	49,62,171
TOTAL	**20,26,882**	**52,52,333**

Schedule-10

T.A.P. VARADAKUTTI & CO. CHENNAI 600 083. Chartered Accountants

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS ON 31ST MARCH 2023

(Amount in Rupees)

SCHEDULE 11 - ESTABLISHMENT EXPENSES	2022-23	2021-22
Pay & Allowances	31,30,69,223	36,88,10,885
CPF Contribution	68,45,652	69,29,700
NPS Contribution	2,89,98,709	3,03,88,739
Medical Reimbursements	12,20,922	13,07,330
Children's Education Allowance	50,68,800	50,14,800
Leave Travel Concession	32,91,276	18,93,142
TOTAL	**35,84,94,582**	**41,43,44,596**

Schedule-11

SCHEDULE 12- ADMINISTRATIVE EXPENSES	2022-23	2021-22
Computer Maintenance/LAN/Software / Maintenance of Plant & Machinery	1,55,36,485	1,31,59,486
Electricity & Water Charges	2,48,91,691	1,63,07,532
Campus Maintenance Expenses	5,71,36,611	3,47,42,920
Vehicles Running and Maintenance	11,44,203	8,26,687
Conveyance Expenses	7,01,682	3,29,539
Travel Expenses	12,44,029	3,58,416
Subscriptions to Journals & Bulletins	18,28,981	16,79,226
Expenses on Seminars & Workshops	60,260	28,15,227
Communication Expenses	18,67,260	22,26,912
Printing and Stationery	13,66,665	11,17,817
Advertisement & Publicity	1,88,007	3,30,006
Rent, Rates and Taxes	22,41,708	33,23,881
Hospitality Expenses	9,02,029	5,64,636
Professional charges	2,21,640	7,92,358
Auditor's Remuneration	82,600	82,600
Other Administrative Expenses	45,91,017	26,69,220
TOTAL	**11,40,04,868**	**8,13,26,463**

Schedule-12

T.A.P. VARADAKUTTI & CO. CHENNAI 600 083. Chartered Accountants

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDED 31ST MARCH 2023

(Amount in Rupees)

RECEIPTS	2022-23	2021-22	PAYMENTS	2022-23	2021-22
I. Opening Bank Balances	1,49,73,57,952	61,37,67,679	**I. Expenses- Assistance to Autonomous Bodies**		
			a) Establishment Expenses	34,46,62,450	31,16,11,980
			b) Administrative Expenses	9,99,10,785	7,43,31,282
II. Grants Received			**II. Payments made against funds for various projects**		
a) Assistance to Autonomous Bodies	47,30,00,000	42,90,00,000			
b) MoES Project Grants	1,53,20,22,896	3,34,63,72,000	a) MoES Project Grants	95,59,21,667	74,03,47,807
c) Sponsored Project Grants from other sources	8,82,956	1,00,38,765	b) Sponsored Projects Payments from other sources	53,88,257	24,31,218
d) Deposit from other agencies	-	7,19,24,791	c) Deposit from other agencies	2,67,17,332	2,53,92,581
III. Scientific & Technical Consultancy Services - RECEIPTS	9,84,59,825	4,38,79,358	**III. Scientific & Technical Consultancy Services - PAYMENTS**	3,43,66,771	6,18,42,554
IV. Deposits Matured	1,10,78,27,252	1,40,57,25,019	**IV. Deposits Made**	97,49,22,292	1,23,25,92,455
			V. Purchase of Fixed Assets/WIP	95,23,99,823	66,00,33,026
V. Interest Received	7,19,28,992	6,61,79,301	**VI. Interest/Other Income /refund of unspent balance remitted to MoES**	5,83,02,745	4,21,75,737
VI. NPS Subscriprtion & Contribution Received	5,20,17,421	5,11,94,021	**VII. NPS Subscription & Contribution deposited to NSDL**	5,49,85,579	6,98,75,899
VII. Other Incomes	44,87,799	96,88,298	**VIII. Other Payments**	1,00,08,64,479	1,37,09,86,632
VIII. Any Other Receipts	11,18,58,986	4,12,09,891	**IX. Closing Bank Balances**	44,14,01,897	1,49,73,57,952
TOTAL	**4,94,98,44,077**	**6,08,89,79,123**	**TOTAL**	**4,94,98,44,077**	**6,08,89,79,123**

For National Institute of Ocean Technology, Chennai

As per our Report of even date
For T.A.P. VARADAKUTTI & Co
Chartered Accountants
FIRM REGN.NO.004511S

Date: August 25, 2023
Place: Chennai 600 100

DIRECTOR

Partner
CA T.A.P.VARADAKUTTI
M. No: 015316
UDIN: 23015316BGWRQY6613

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULE-13: SIGNIFICANT ACCOUNTING POLICIES

1. GENERAL INFORMATION:

(i) The Government of India under the Gazette Notification Resolution No.DOD/16-TE/16/92 dated 1st September 1993 established the National Institute of Ocean Technology (NIOT).The main objectives of the Institute are:

(a) To apply the knowledge and experience gained through research in ocean sciences to develop technical know-how and capabilities in specific fields of ocean technology such as seabed mining, ocean energy, etc.

(b) To assist the ocean scientists in development of suitable ocean engineering and instrumentation systems such as data buoys, observation platforms, underwater vehicles, etc.

(c) To develop necessary technologies for the fast-emerging concept of Coastal Zone Management for comprehensive and sustainable development of the coastal belt and islands of the country and

(d) Any other objectives relating to Ocean Technology as may be set by the Ministry of Earth Sciences (MoES).

(ii) National Institute of Ocean Technology (NIOT) has been registered under Tamil Nadu Societies Registration Act, 1975 on 5th November 1993 under the Registration No.541/93.

(iii) NIOT functions under the administrative control of the Ministry of Earth Sciences (MoES) and provides necessary technological inputs in such areas of Ocean Development as MoES may decide.

(iv) The Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India vide their letter No.11/358/1998-TU-V dated 23rd March 2022 renewed the recognition of National Institute of Ocean Technology, Chennai as a Scientific and Industrial Research Organization from 1st April 2022 to 31st March 2025.

(v) Based on the renewal of the above said registration, the Institute is eligible to avail Concessional Customs Duty at the rate of 5% advalorem upto 31st March 2024 in terms of Government of India Notification No.51/96-Customs dated 23rd July 1996. The Central Board of Indirect Taxes and Customs (CBIC) vide Notification No.11/2022-Central Tax (Rate) dated 13th July 2022 has rescinded the Notification No. 47/2017-Integrated Tax (Rate) dated 14th November 2017 the concessional GST

Rate of 5% (2.5% each on CGST and SGST or 5% IGST) on the purchase of Scientific and Technical Equipment and change it to rate applicable on such scientific and technical equipment with effect from 18th July 2022. Further NIL Rate of IGST in respect of import of goods as per Sub section (7) of Section 3 of the Customs Tariff Act 1975 has also been withdrawn with effect from the said date.

(vi) The Director of Income Tax (Exemptions), Chennai vide order No.DIT (E) No.2(582)/04-05 dated 22.3.05 granted registration under Section 12AA of the Income Tax Act, 1961 as a Public Charitable Trust. In the Finance Act 2020, a new Section 12AB, has been introduced according to which the status of charitable institution needs to be renewed and the same will be in force for 5 years. Based on this, the Application was filed and from the Income Tax Department, Provisional Registration Certificate bearing No.AAATN0530GE20206 has been granted to the institute with effect from Assessment Year 2021-22 to 2023-24. Further, application for renewal of such registration has been made on 25th May 2023 which is pending with the Income Tax Department.

(vii) The Institute has been notified as Scientific Research Institution under Section 35(1) (ii) of the Income Tax Act 1961 read with Rules-5C and 5E of the Income Tax Rules, 1962 vide Notification No.45/2012 (F.No.203/51/2011/ITA-II) dated 29th October 2012 from Assessment year 2011-12 onwards.

(viii) The NIOT is a level II entity as defined in Preface to Accounting Standards issued by the Institute of Chartered Accountants of India. Accordingly, the NIOT has complied with all the Accounting Standards applicable to small and medium size entities unless otherwise stated.

2. ACCOUNTING CONVENTION:

The accompanying financial statements have been prepared under the historical cost convention basis in accordance with the Generally Accepted Accounting Principles (GAAP) in India and comply with the mandatory accounting standards unless otherwise stated.

The preparation of the financial statements in conformity with GAAP requires management to make estimates and assumptions that affect the reported balances of assets and liabilities and disclosures relating to contingent assets and liabilities as at the date of financial statements and reported amount of income and expenditure during that period. Difference between actual results and estimates are recognised in the period in which results are known / materialised.

3. RECOGNITION OF INCOME:

(i) Government grants are accounted on receipt basis.

(ii) Revenue from Technical / Scientific services is accounted on completed service contract method of accounting which recognises revenue in the statement of Income and Expenditure, only when the rendering of service under a contract is completed or substantially completed.

(iii) In respect of 'Core Grant-Capital' received from MoES, income is recognized in Statement of Income and Expenditure equivalent to depreciation charged on the assets and debited in the Statement of Income and Expenditure as per Accounting Standards-12.

4. FIXED ASSETS:

(i) Fixed Assets are carried at cost less depreciation limited to residual value.

(ii) The cost of an asset comprises of its purchase price and other relevant expenses attributable for bringing the assets to usable condition.

5. DEPRECIATION:

(i) Depreciation is provided on the written down value method at the rates specified in Income Tax Act, 1961.

(ii) Depreciation relating to the schemes viz., Ocean Services, Modelling Application, Resources and Technology (O-SMART) and Deep Ocean Mission (DOM) are charged to the assets and deducted from the respective Capital Fund.

(iii) Depreciation on assets created out of NIOT's internal revenue generation are charged to the assets and deducted from Scientific and Technical Project Equipment Fund created out of Technical/Consultancy Project.

(iv) Depreciation relating to assets created out of Core Grants are charged to the assets and also shown in Income & Expenditure account.

6. VALUATION OF INVENTORIES:

Since the purchases of raw materials, consumables and other inputs are restricted to minimum requirement of Research Programmes taken up and, centralised stores registers are not maintained and these items are charged at cost to the respective projects on receipt and inspection, the valuation of inventories as at the end of the year not made and not brought into accounts as closing stocks.

7. RESEARCH AND DEVELOPMENT EXPENDITURE:

(i) The Institute is receiving funds each year for certain specified schemes approved by Ministry of Earth Sciences, Government of India for the purpose of acquiring assets and meeting revenue expenses towards research and development activities of the Institute. The receipts and utilization of these specified funds for the schemes are shown in Schedule-3 forming part of Balance Sheet.

(ii) Research and Development expenditure on Scientific and Technical Consultancy Services are accumulated separately under 'Project Advances' (as per Schedule-4B) which are carried out as net of such expenditure till completion of the project. The incomes as well as expenditure relating to the completed projects during the year are charged to Statement of Income & Expenditure in the year of completion of the project.

8. RATE OF EXCHANGE:

Transactions in foreign currencies are recorded at the exchange rate prevailing on the date of transaction. The forex gains or loss arising at the time of settlement of the liability is separately ascertained and the net forex gain or loss is adjusted to the respective project. Foreign currency monetary assets and liabilities are converted into INR at the year-end exchange rates and the resultant difference, if any, is recognized as exchange loss or gain. The net forex gains or loss adjusted to the contracts covered under MoES Projects and Scientific & Technical Consultancy Projects for the current financial year is Rs.26,15,533/- (Previous financial year Rs.3,22,288/-).

9. UNIFORM FORMAT OF ACCOUNTS FOR CENTRAL AUTONOMOUS BODIES:

The accounts are prepared as per the Uniform Format of Accounts for Central Autonomous Bodies.

10. LONG TERM EMPLOYEE BENEFITS

a) Defined Contribution Plan:

The NIOT had the following defined contribution plans:

(i) Contributory Provident Fund (CPF) scheme for its staff who have joined before 1st January 2004 and is administered by the Institute.

(ii) National Pension System (NPS) for its staff who have joined after 1st January 2004 and is administered by the Pension Fund Regulatory and Development Authority.

The above mentioned schemes are classified as Defined Contribution Plan as the Institute has no further obligation beyond making the contributions.

The Institute's contributions to the Defined Contribution Plan are charged to Statement of Income &Expenditure on accrual.

b) Other Terminal Benefits:
Gratuity, leave encashment are paid from the funds created for Terminal Benefits.

For NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

DIRECTOR

As per our Report of even date
For
T.A.P. VARADAKUTTI & Co.
Chartered Accountants
Firm Reg. No: 004511S

Partner
CA T.A.P.VARADAKUTTI
M. No: 015316
UDIN: 23015316BGWRQY6613

Date: August 25, 2023
Place: Chennai 600 100

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULE-14: CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

1. Contingent Liabilities: -

a. Relating to Arbitration award Rs.3,01,99,447/-

After the expiry of the contract period on 16/12/2013 in respect of the Total Management Contract for the Technology Demonstration Vessel 'Sagar Nidhi' by M/s. ABS Marine Services Pvt. Ltd., the vessel was handed over back to NIOT on 31/01/2014 after the expiry of 46 days and to compensate this delay, NIOT has invoked the three Performance Bank Guarantees given by M/s. ABS Marine Services Pvt. Ltd. amounting to Rs.1,12,92,811/- and advance Bank Guarantee amounting to Rs.51,68,477/-. There is an Arbitration award against NIOT but favouring M/s. ABS Marine Services Pvt. Ltd. amounting to Rs.3,01,99,447/- consisting of Rs.1,37,38,159/- towards vessel management charges for 46 Days and Rs.1,64,61,288/- towards refund of Bank Guarantees. M/s.ABS Marine Services Pvt. Ltd. by its letter dated 31/03/2023 demanded refund of Rs.2,35,70,699/- to resolve and bring a closure to the long pending issues.

However, there is an award in favour of NIOT and against M/s. ABS Marine Services Pvt. Ltd. amounting to Rs.7,95,86,686/- towards damages arising out of the breach committed by M/s.ABS Marine Services Pvt. Ltd. and in the first appeal before the single judge of the HC of Madras, it was held in favour of NIOT. The division bench quashed the order of the single judge and ordered for denova inquiry and this order has been challenged by NIOT by way of SLP before the Hon'ble Supreme Court. Since the SLP filed by NIOT in respect of above award is pending for hearing before the Honourable Supreme Court, no adjustments were made in the books of accounts in respect of the above.

b. Capital Commitments not provided for but treated as Contingent Liability

In respect of 'Development of Personnel Sphere for Manned Submersible' as per MoU between NIOT and Vikram Sarabhai Space Centre (VSSC) dated 8th May 2019, and further Amendment No.1 issued to MoU dated 08.05.2019 for the amount of Rs.54.31 crores, a sum of only Rs.42.00 crores has been paid as per the demand/s made by VSSC till 21/10/2022. The balance sum of Rs.12.31 crores is a pending commitment of NIOT in the nature of a contingent liability in respect of the above MoU since the payment has to be made by NIOT as and when demands are made by VSSC.

2. Retirement Benefits to employees

The regular employees of Central Autonomous Bodies are eligible for Gratuity and Leave Encashment. As per the Accounting Standards-15 (revised), the approximate accrued liability in respect of Retirement Benefits is to be provided in the Books of Accounts. Life Insurance Corporation of India has been entrusted for managing the Terminal Benefits Fund by availing Policy for Group

Gratuity Scheme and Policy for Group Leave Encashment Scheme and thereby Rule 230(12) (ii) of GFR 2017 has been complied with. Total accrued liability in respect of Gratuity and Leave encashment scheme provided by LIC of India as per Actuarial Valuation as on 31.03.2023 in respect of the regular employees (186 Nos.) of NIOT is furnished below:-

Policy No	Scheme	Liability as per Actuarial Valuation along with service cost as on 31.03.23	Funds available with LIC in Policy Account as on 31.03.23	Balance Payable towards accrued liability as on 31.03.23
		(A)	(B)	(A-B)
				(in Rupees)
605009094	Group Leave Encashment	16,78,06,939/-	15,58,18,492/-	1,19,88,447/-
605009095	Group Gratuity	12,82,86,920/-	12,57,70,177/-	25,16,743/-
		29,60,93,859/-	28,15,88,669/-	1,45,05,190/-
Payable to LIC as on 31/03/2023 (for which provision have been made in the Books of Accounts)				1,45,05,190/-

3. Status of Insurance Claims

Total estimated claim of Rs. 21.12 Crores as on 31.03.2023 has not been settled by the Insurance companies, since the claims are under the assessment by the Insurance companies. Insurance claims will be accounted only on actual receipt basis.

4. MoES Project Grants – Implemented by NIOT and project grants sanctioned and received from Ministry of Earth Sciences

a. During the financial year 2022-23, NIOT received total amount of Rs.153,20,22,896/- (Previous Financial Year 2021-22: Rs.334,63,72,000/-) as Grants-in-aid for various projects under the Scheme.

b. Capital Advances appearing in Schedule-5 of Balance Sheet comprises of the following:

(i) Advance for Land Acquisition for Sea Front Facility at Nellore, Andhra Pradesh a sum of Rs.1,05,29,134/- (being unspent balance as per the District Collector office letter dated 22.06.2022)

(ii) Advances to CPWD for Infrastructure of Rs.31,59,00,254/-

(iii) Advances to Vikram Sarabhai Space Centre (VSSC) of Rs.42,00,00,000/-

(iv) Advance to other institutions of Rs.20,15,31,781/-

c. Interest/Other incomes & Unspent balance of Rs.3,21,20,824/- (appearing in Schedule-4: Other Current Liabilities) earned and accrued during the year is refundable to the MoES.

T.A.P. VARADAKUTTI & CO. CHENNAI 600 083. Chartered Accountants

5. **Interest Earned / Other Receipts Refundable to MoES**
During the financial year 2022-23, the Bank Interest of Rs.2,44,91,059/- and Other Receipts Rs.35,44,847/- under the MoES Projects for the Scheme, O-SMART & DEEP OCEAN MISSION totalling to Rs.2,80,35,906/- and Savings Bank Interest Rs.19,77,732/- and Other Receipts Rs.20,26,882/- on Core Grant totalling to Rs.40,04,614/- included in the total amount of Rs.3,20,40,520/- (Actual Interest Received/Other Income is Rs.3,19,83,684/- and Interest Accrued is Rs.56,836/-). Since this amount of Rs.3,20,40,520/- is refundable to MoES, the same is shown under the head 'Other Current Liabilities – Interest and other receipts refundable to MoES'.

6. **Grants in Aid – Core Grant**
NIOT received the Core Grant of Rs.47,30,00,000/-during the financial year 2022-23 (Previous Financial Year 2021-22:Rs.42,90,00,000/-) towards Manpower, Operational and Maintenance Expenses from the Ministry of Earth Sciences in the form of Core Grant-Salary, General and Capital as specified under Schedule-8 forming part of Income & Expenditure account.

7. The sum of Rs.17,75,03,904/- shown in Sch-3 as Earlier year Adjustment for which the equivalent amount is credited to Capital fund, since such advances to capital projects were directly grouped under Sch -5 during the prior periods.

8. **Withdrawal of liability towards amount payable to Shipping Corporation of India of Rs.31.05 crores**
A total sum of Rs.31.05 crores has been provided in earlier years towards operations, maintenance and management of research vessels viz, Sagar Nidhi, Sagar Manjusha and Sagar Purvi payable to Shipping Corporation of India Ltd. The liability of Rs.31.05 crores has been withdrawn during the year and shown as reduction from the total expenditure of Rs.66.53 crores incurred during the year and the net expenditure of Rs.35.48 crores shown under the head 'Revenue Expenditure' in Schedule-3 under the project title 'Operation and maintenance of research vessels' and corresponding reduction of liability made in Schedule-4 Outstanding Liabilities.

9. **Accounting for Depreciation of Rs.53,48,84,892/-in the Fixed Assets Schedule.**
a. Depreciation Rs.3,51,94,323/- is charged to Income & Expenditure Account for the Assets created out of Core Grant and deducted from the Fixed Assets value shown in Schedule-5: Fixed Assets forming part of Balance Sheet.
b. Depreciation Rs.48,09,00,398/- is charged against Capital Fund on Assets created out of Schemes viz., O-SMART & Deep Ocean Mission

and deducted from the Fixed Assets value shown in Schedule-5: Fixed Assets forming part of Balance Sheet.

c. Depreciation Rs.1,87,90,171/- is charged against Scientific & Technical Consultancy Project Equipment Fund in Schedule-2 forming part of Balance Sheet for the Assets created out of Scientific & Technical Consultancy Projects and reduced from the Fixed Assets value shown in Schedule-5: Fixed Assets forming part of Balance Sheet.

10. Projects and Utilisation Certificates

In respect of project advances given by NIOT to academic institutions and R&D organisations for collaboration during execution of the projects, such institutions / organisations render the Utilisation Certificates along with the Statement of Expenditure for the year ending 31st March of each financial year which are accounted in the respective projects as revenue expenditure.

The assets created out of such collaboration are retained by the academic institutions and R&D organisations after obtaining an undertaking with a declaration that without the written consent of the NIOT, they will not create, encumber or alienate any mortgage, lien or charge by way of hypothecation, pledge otherwise, or dispose of the assets. If the assets are transferred to NIOT, necessary stock entry will be made for such transfer and will be merged with the Fixed Assets by credit to the Capital Fund.

11. The total turnover/ gross receipts declared for Scientific & Technical Consultancy Services as per GST Returns filed for the financial year 2022-23 Rs.10,34,79,084/- is as per the tax invoices raised by NIOT on the clients during the year, whereas Scientific and Technical consultancy services as per Statement of Income and expenditure is Rs.6,72,08,604/- as per the accounting policy followed by NIOT for accounting Income from Scientific & Technical Consultancy Services based on Completed Contract method as per Significant Accounting Policies vide Note 3 (ii) above.

12. Expenditure on Scientific & Technical Consultancy Services of Rs.5,78,37,759/- comprising of Revenue Expenses of Rs.5,52,55,464/- and capital expenses of Rs.25,82,295/-in the Income & Expenditure account is the total expenses incurred in respect of the consultancy services projects completed during the year.

13. NIOT Maintains a separate Savings Bank account with Canara Bank named as NIOT NPS account in which recovery from employees who are covered under NPS as well as NIOT Contributions for them are deposited and payments to NSDL account are made from that account. However in respect of 12 employees who have been disputing their coverage to NPS, the recovery of their subscriptions and NIOT contributions for them have not been remitted to NSDL A/C but kept in savings bank account itself since they didn't furnish PRAN but challenged before the Honourable CAT. However, the savings Bank interest accruing in this account since 2013 and up to 31st March 2023 amounting to Rs.47,32,393/- is shown as general liability.

14. **Taxation**
Since NIOT is registered under section 12AA of the Income Tax Act, 1961 and the income earned by NIOT has been claimed as exempt under section 11/12 of the Income Tax Act 1961, no provision for Income tax has been considered necessary.

15. Figures shown in the accounts are rounded off to the nearest rupee.

16. Previous year figures have been re-grouped / re-classified wherever necessary in conformity with the modifications made in the current year financial statements.

17. Schedules 1 to 14 annexed to herein are integral part of the Balance Sheet as at 31st March 2023, Statement of Income and Expenditure and Statement of Receipts and Payments for the year ended on that date.

Signatures to Schedule **1** to **14**

For NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

DIRECTOR

As per our Report of even date
For
T.A.P. VARADAKUTTI & Co.
Chartered Accountants
Firm Reg. No: 004511S

Partner
CA T.A.P. VARADAKUTTI
M. No: 015316
UDIN: 23015316BGWRQY6613

Date: August 25, 2023
Place: Chennai 600 100

Workshop on the Prospects of Deep-Sea Mining in sensitizing the Indian industry, policy makers and academia on the opportunities in the area. The workshop was held at NIOT on 27th Jan 2023 and was attended by renowned industrialists and policy makers and academic institutions like IITs etc.

The Workshop for Stakeholders on Indian Coastal Inlets Restoration Program (ICIRP) was held in Tamil Nadu and Kerala which was attended by various departments of the states. The main objective of the workshop was to highlight the importance of coastal inlets and its functional performance.

The 29th Foundation of Day of NIOT along with the 25th year foundation of the Ocean Observation Systems erstwhile National Data Buoy Programme was celebrated on 14th November 2022 at NIOT, Chennai. The Chief Guest – His Excellency Mr. Hans Jacob Frydenlund, Norwegian Ambassador to India, participated as Chief Guest along with Dr.M.Ravichandran, Secretary MoES and Dr.G.A. Ramadass, Director NIOT. Former Secretaries of MoES, Former Directors of NIOT, Directors of MoES were honored during the function.

The International Women's Day was celebrated by NIOT on March 7, 2023. Dr.N. Anandavalli, Director, CSIR-SERC, Chennai graced the occasion as the Chief Guest and delivered the Women's day Special address. A booklet titled "Women in Ocean Technology" was released by the Chief Guest. Dr. G.A.Ramadass, Director, NIOT gave Women's day remarks.

NIOT Chennai

Seafront Chittedu

ACOSTI Port Blair

Seafront Pamanji

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
(Ministry of Earth Sciences, Govt. of India)
NIOT Campus, Velachery- Tambaram Main Road,
Pallikaranai, Chennai - 600 100, India.
Tel : +91-44-6678 3300 / Fax : +91-44-6678 3571
Email : postmaster@niot.res.in
Web : www.niot.res.in