Annual Report 2021-22

National Institute of Ocean Technology

(Ministry of Earth Sciences, Govt. of India)

The first manned ocean mission “Samudrayaan” was launched by Hon’ble Minister for Earth Sciences Dr. Jitendra Singh in the presence of Secretary, MoES, and Director, NIOT on October 30, 2021 at NIOT.

Dr.Jitendra Singh, Hon'ble Minister of State (Independent Charge) of the Ministry of Earth Sciences and Ministry of Science & Technology visited NIOT facilities and presided over the NIOT's 28th Foundation day celebration. Dr.M.Ravichandran, Secretary MoES participated in the event and released E-Samudrika newsletter of NIOT in 3 languages English, Hindi and regional language Tamil.

Bhoomi Pujan ceremony was performed on 31 March 2022 by Shri Praful Patel, Administrator, UT Lakshadweep, in the presence of Dr. G.A. Ramadass, Director, NIOT and members from both NIOT and Lakshadweep administration.

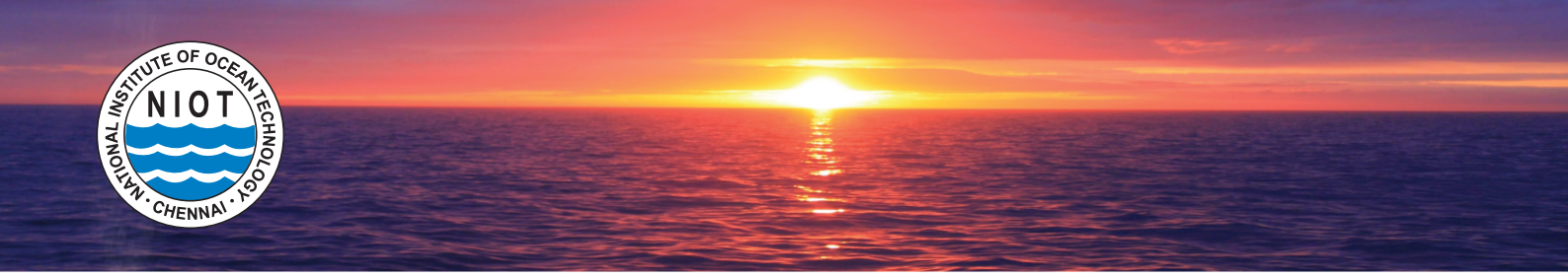
NIOT celebrated 73rd Republic Day on 26thJanuary 2022. Dr.G.A.Ramadass, Director NIOT hoisted the national flag and delivered the speech on achievements and forthcoming commitment and deliverables to NIOT staff and scientists

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 Council 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 functioning 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 and integration bays. The integration bays are used for assembly and integration of large-scale deep ocean testing equipments 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.

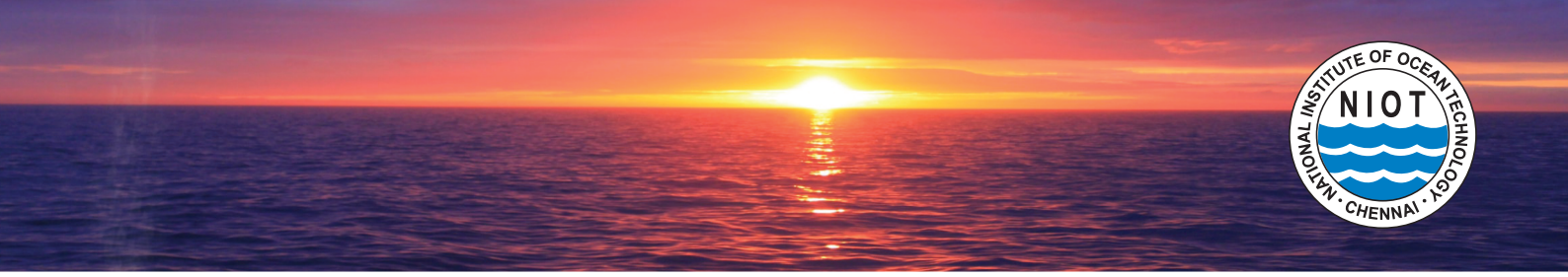


Mandate of NIOT

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 the 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 COUNCIL AND THE GENERAL BODY OF NIOT FOR THE YEAR 2021-22

1	Dr.M.Rajeevan Secretary to Govt. of India Ministry of Earth Sciences, New Delhi	Chairman From 7th December 2015 To 31st July 2021
	Dr.Shekhar C Mande Secretary to Govt. of India Ministry of Earth Sciences, New Delhi	Chairman From 1st August 2021 Till 10th October 2021
	Dr.M.Ravichandran Secretary to Govt. of India Ministry of Earth Sciences, New Delhi	Chairman From 11th October 2021
2	Shri.Vishvajit Sahay AS &FA Ministry of Earth Sciences, New Delhi	Member From 16th November 2020
3	Ms. Anju Bhalla Joint Secretary Ministry of Earth Sciences, New Delhi	Member From 17th January 2021 till 21st May 2021
	Mrs.Indira Murthy Joint Secretary Ministry of Earth Sciences, New Delhi	Member From 22nd May 2021
4	Dr.P.S.Goel, Chairman-SAC,NIOT & Former Secretary, NIOT	Member From 16th September 2016
5	Dr. T. Srinivasa Kumar Director, INCOIS	Member From 28th August 2020
6	Dr.K.Murali HOD, Dept. of Ocean Engg., IIT Madras	Member From 21st February 2020
7	Shri.S.Anantha Narayanan Former Director, NPOL, Kochi	Member From 9th May 2018
8	Dr.M.V.Ramana Murthy Director, NCCR, Chennai	Member From 30th May 2017
9	Dr.M.P.Wakdikar Advisor, Ministry of Earth Sciences, New Delhi	Permanent Invitee From 30th May 2017 Till 19th May 2021
	Dr. Vijay Kumar Scientist-G, Ministry of Earth Sciences, New Delhi	Permanent Invitee From 20th May 2021
10	Dr.B.N.Suresh Former Director, ISRO	Member From 9th May 2018
11	Representative Niti Aayog, New Delhi	Permanent Invitee From 30th May 2017
12	Dr. G.A. Ramadass Director, NIOT, Chennai	Member Secretary From 22nd December 2020

FROM THE DIRECTOR'S DESK

Greetings from National Institute of Ocean Technology (NIOT).

This has been the year of transit from despair to hope. It is my pleasure and privilege to give an account of our activities for the year 2021-22.

The entire world is emerging out of pandemic and there are green shoots all around. At NIOT too we bounced back to near normalcy. We protected our campus and staff from COVID-19 by conducting several vaccination camps and periodic disinfections of the campus. Despite all our precautions we lost one of our staff member to the pandemic. We are thankful to our Ministry and the Government of India for helping us in our fight against the pandemic and in bringing our institute back on rails. Inspite of lockdown, working on rosters and fund crunch, we are happy to inform you that, NIOT achieved many of the objectives set for itself.

Significant progress was achieved in the Ocean Technology areas of Ocean Energy, Freshwater, Climate Change, Deepwater Research, sustainable Coastal Protection, Ocean Acoustics, Ocean Electronics, Marine Biotechnology. As per our mandate design, development and demonstration of technologies were carried out and some of these technologies were transferred to industry for possible commercialization.

NIOT's contribution towards safe drinking water to the island communities in the UT-Lakshadweep has been substantial. NIOT's Low Temperature Thermal Desalination (LTTD) technology has been successfully demonstrated in Kavaratti, Minicoy and Agatti and catering to local community drinking water needs. Presently work is in progress in the 6 islands of Amini, Androth, Chetlat, Kadamat, Kalpeni and Kiltan. While there has been a setback in deadlines due to Covid restrictions, generation of potable water at Kalpeni Island has commenced.

With regard to the establishment of the first of its kind OTEC (Ocean Thermal Energy Conversion) powered desalination plant in Lakshadweep, contracts for process, civil, and HDPE (High Density Polyethylene) pipe supply and welding comprising three work packages were signed and works have commenced.

In order to establish a waste heat recovery plant at Tuticorin Thermal Power Station, two tenders for civil construction and process equipment have been floated, and successful bidder has been identified for the process component. An Android based application to access all real-time data was developed and is being implemented in the wave-powered navigational buoy.

It is my pleasure to inform about the successful locomotion trials of the self-propelled Seabed Mining Machine, Varaha-1 which has been carried out at one of the world record depths of 5270 m, the first by any nation. This has been done during the peak of pandemic.

For implementation and sustainable coastal protection measures, NIOT is actively involved with the stakeholders in designing and providing guidance for field implementation. Presently NIOT is involved with the Kerala State Government for beach restoration at Poonthura, off

Thiruvananthapuram coast. In order to resolve water quality issues inside creeks / estuaries and improve the dilution capacities and storm water management, NIOT is carrying out studies for sustainable mouth opening scheme for Adyar inlet as part of the Coastal Inlets Research Program. Wave Atlas is being continually updated with data inputs and sensitivity analysis of hind cast wave model has been completed for creating the next version of the Atlas.

With improvement in the pandemic situation, NIOT has gone full swing into all the field activities and technology demonstration which were impeded during the lockdown. The year was marked by visits of several dignitaries of which notable one was launching of the first manned ocean mission "Samudrayaan" by the Hon'ble Minister for Earth Sciences Dr. Jitendra Singh in the presence of Secretary, MoES, and Director, NIOT on 30th October 2021 at NIOT. Human acclimatization trials for nearly 2 hours was undertaken for the 500m depth-rated personnel sphere which has been designed and developed inhouse at NIOT and certified by Det Norske Veritas (DNV). The human acclimatization test for the human sphere was carried out at NIOT's Acoustic Test Facility with 3 persons at 7m water depth.

NIOT's contribution to marine / ocean electronics and ocean acoustics has shown significant progress. In an effort towards indigenization of acoustic systems for underwater applications like telephones, seabed imaging SONARs etc., transducers and hydrophone arrays are being developed and technology demonstration is being planned.

In order to carry out measurements over long period, a new deep-water ambient noise system is deployed in the Arabian sea as part of OMNI mooring with 2 hydrophones, with low power data acquisition systems. Key Comparison exercises are constantly undertaken and test results for Hydrophone Calibration by NPL, UK indicate that calibration results of all the countries compare well with that of NIOT.

NIOT has been active in transferring its technology to the industry for production. Some of the research products include biosurfactant from marine bacteria for environmental clean-up and waste management, recombinant ectoine from deep sea bacteria for skin care and cosmetic applications, deep sea microbial consortia technology for bioremediation of petroleum hydrocarbon and oil spill in marine environment. A laboratory-scale ballast water test facility has been established at NIOT with NABL accreditation for testing of chemical parameters in the seawater. Efforts for creating a field Ballast Water Test Facility in conformance with IMO guidelines is being undertaken at the NIOT Seafront facility.

The long-term requirement of fishing community on automation of the open sea fish cage culture system and a solution for automatic fish feed system is developed and prototype has been deployed off Andaman Islands. It is heartening to share that using Artificial Intelligence a bio-mass estimation device is developed for supporting the fisherman community in evaluating growth of fish nurtured by the cage culture method. Deep Sea Autonomous Underwater Profilers, operable up to 5000m water depths is developed in-house using indigenized variable buoyancy engine suitable for operations in Bay of Bengal.

I am happy to share that with the acquisition issues of the pending 56 acres of NIOT land at proposed Seafront Research Facility (SRF) has been resolved and handed over to NIOT by District Administration. SPSR Nellore, Andhra Pradesh, all efforts for creation of infrastructure for research like the ballast water treatment test facility and approach trestle are underway.

In the field of ocean observations, NIOT has made significant contribution with the buoy network and HF Radar. With a mandate to deploy and maintain the Moored Omni Buoy and Tsunami

buoy network for the nation, NIOT has been making significant contribution by providing real time observations of meteorological & oceanographic parameters for supporting IMD. CALVAL buoy system triggered rapid mode transmission on 13th May 2021 during Tauktae cyclone pass. Six indigenous ocean observation technologies developed in-house were transferred to Industries.

Ten HF Radar are being maintained in remote locations along Indian coast and data is being collected. Significant progress has been made in the EEZ program with bathymetry data being collected along the east coast.

NIOT's research vessels provide floating infrastructure to its research activities. Coastal Research Vessel Sagar Anveshika participated in the 12th Presidential Fleet Review-2022 by the Hon'ble President of India held at Visakhapatnam on 21st February, 2022 and demonstrated the scientific strength and capacity in respect to acquisition of marine scientific data and ocean observations for various programs of the Government of India.

The support of Finance & Accounts, Stores & Purchase and Establishment & Personnel for facilitating NIOT's research programs is significant and deserves special mention. The efforts of the Estate and Maintenance section in the upkeep and maintenance of the NIOT Campus is laudable. Their efforts in organizing vaccination camps deserves to be recognized. Efforts of the NIOT Computer Maintenance Cell in upkeep and maintenance of the network is highly appreciated. It has ensured a good connectivity for online meetings and webinars.

NIOT team has made significant contribution to the organization and conduct of the IEEE-OCEANS jointly with IIT Madras which needs special mention.

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. Results of the research work carried out by NIOT were published in reputed peer reviewed journals.

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 Council, 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 / Deep Sea Technologies

- Development of Integrated Mining System for Mining Polymetallic Nodules from 6000m
- Development of Manned and Unmanned Underwater Vehicles

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 Sensors & 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

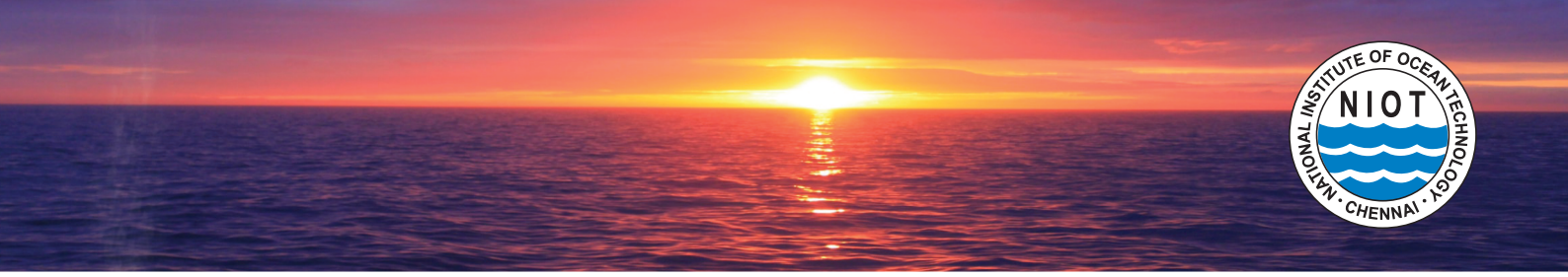
(iii) Vessels

- 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.



OCEAN TECHNOLOGY AREAS

SERVICE TO SOCIETY

- Ocean Observation Network
- HF Radar Network
- Coastal Engineering
- Coastal Processes
- Ocean Science & Technology for the Islands
- Shallow Water bathmetry-EEZ Surveys

TECHNOLOGY DEVELOPMENT FOR RESOURCES

- Energy and Freshwater
- Mineral Exploration Research
- Deep Sea Mining
- Studies on Gas Hydrates
- Desalination - Ocean Structures

NICHE TECHNOLOGIES

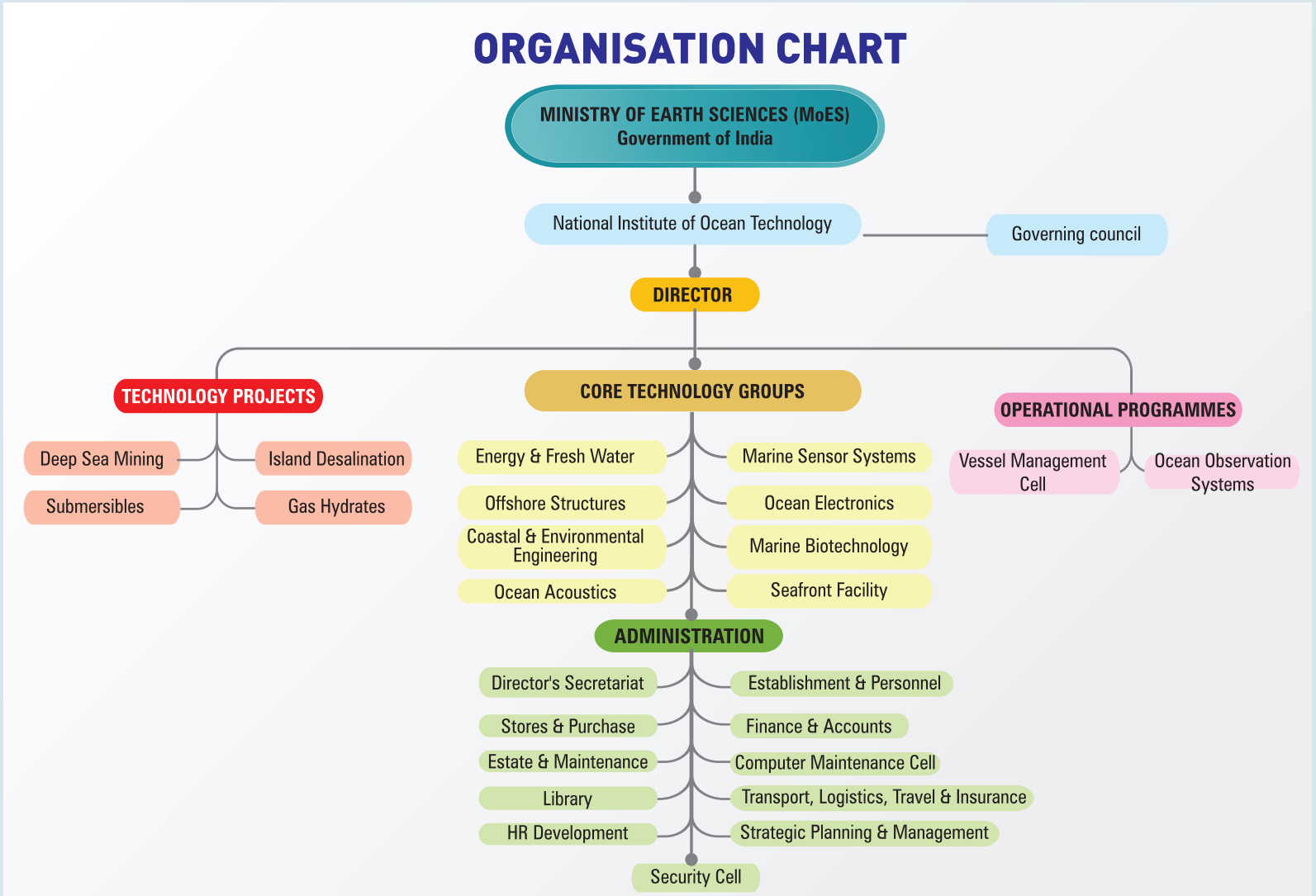
- Manned and Unmanned underwater Vehicles
- Marine Sensor Systems
- Ocean Acoustics
- Ocean Electronics

INFRA-STRUCTURE

- NIOT Vessels
- Seafront Facility

Director is the Head of the Institute.
All Operational, Core technology research, administration and infrastructure groups report to the Director.

ORGANISATION CHART



2. MAJOR ACCOMPLISHMENTS OF THE YEAR 2021-22

I. DEEP OCEAN MISSION

- The first Indian manned ocean mission "Samudrayaan" was launched by the Hon'ble Minister for Earth Sciences Dr. Jitendra Singh in the presence of Secretary, MoES, and Director NIOT on 30th October 2021 at NIOT.
- Successful locomotion trials of the self-propelled Seabed Mining Machine, Varaha-1 (V1) was carried out at depth of 5270 m. A 500m depth-rated personnel sphere is certified by DNV for man-rated operations and tested for human acclimatization for a period of two hours at an in-house test facility with 3 persons at 7m water depth.
- Factory acceptance tests and Qualification trials of the 6000m depth-rated Autonomous Underwater Vehicle (AUV) was completed at 1000m depth in Norway. AUV and associated systems were then received at NIOT.

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

(i) OCEAN TECHNOLOGY

- Contracts for three work packages viz. process, civil, and HDPE (High Density Polyethylene) pipe supply and welding were signed and works were commenced to establish an OTEC powered desalination plant at Kavaratti in UT Lakshadweep.
- Two tenders for civil construction and process equipment have been floated to establish a waste heat recovery plant in 2x1 million litres per day capacity at Tuticorin Thermal Power Station, and a successful bidder has been identified for the process component.
- An Android based application to access real-time data was developed and is being implemented in the wave-powered navigational buoy.
- Installation and operationalization of Low Temperature Thermal Desalination plant at Kalpeni Island of UT Lakshadweep.
- Detailed engineering design studies for coastal protection off Poonthura coast in Kerala was carried out for the implementation under the guidance of NIOT.
- Deployment of first segment of submerged offshore breakwater was completed and adjacent beach was formed due to breaking of high waves on the submerged offshore breakwater.
- Design and development of sustainable mouth opening scheme designed for Adyar inlet as part of the Coastal Inlets Research Program.
- Sensitivity analysis of hindcast wave model has been completed for wave atlas version-2.
- Biosurfactant from marine bacteria for environmental clean-up and waste management technology and Recombinant Ectoine from deep sea bacteria for skin care and cosmetic applications technology transferred to M/s. Eco Build Corp Private Limited, Bengaluru, Karnataka, through NRDC.
- Bioremediation of petroleum hydrocarbon and oil spill in marine environment by deep sea microbial consortia technology transferred to M/s. Eco Build Corp Private Limited, Bengaluru, Karnataka, through NRDC.

- Lab-scale ballast water test facility at OSTI lab, Chennai, has been established and its NABL accreditation as per ISO/IEC 17025:2017 for testing of chemical parameters in the seawater was received.
- Technology demonstration of indigenous Underwater Acoustic Telephone (UAT) for the 500m manned submersible as priority in the first phase is initiated.
- Key Comparison test results for Hydrophone Calibration by NPL, UK showed that the calibration results of all the countries were compared well including that of NIOT.
- Deployment of a new deep water ambient noise system in the Arabian sea as a part of OMNI mooring with 2 hydrophones, with low power data acquisition system for measurements over long period.
- Deep Sea Autonomous Underwater Profiler (operable up to 5000m) is developed in-house using indigenized 1000 CC variable buoyancy engine which is suitable for operations in Bay of Bengal.
- An automatic fish feed system is developed using rigid sphere type cages and proto unit was deployed off Andaman Islands and it's performance is monitored.
- Bio-mass estimation device developed using Artificial Intelligence (AI) supports the fisherman community in evaluating fish growth which are being nurtured inside the surface and submersible cages.
- Drone technology was used for the first time in India for marine applications and sea trials were carried out with automatic water quality sampler using a 10 kg payload.
- Land acquisition issue with respect to 56 acres of land at Seafront Research Facility (SRF), SPSR Nellore has been resolved, and the land was handed over to NIOT by the District Administration.
- Subsidence analysis during the dissociation phase of methane hydrate extraction based on methane hydrate reservoir characteristics from Krishna Godhavari basin.

(ii) OCEAN OBSERVATION NETWORK

- The buoy systems have captured the signals of two cyclones and assisted IMD by providing real time observations of meteorological & oceanographic parameters. CALVAL buoy system triggered rapid mode transmission on 13th May 2021 during Tauktae cyclone pass.
- Six indigenous ocean observation technologies developed in-house were transferred to Industries (M/s.L&T, Mumbai, CT Control Technologies, Bengaluru, and M/s.Norinco India Private Ltd, Mumbai).
- The OMNI-RAMA joint data portal developed by NIOT-OOS & INCOIS in association with NOAA-PMEL, USA was launched on 9th August 2021.
- Operated and maintained 10 HF Radar remote sites installed along Indian coast successfully.

(iii) OPERATION AND MAINTENANCE OF RESEARCH VESSELS

- Coastal Research Vessel Sagar Anveshika participated in the 12th Presidential Fleet Review-2022 by the Hon'ble President of India held at Visakhapatnam on 21st February, 2022 and demonstrated the scientific strength, capacity in respect of acquisition of marine scientific data and ocean observations for various programmes of the Government of India.

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

- Shallow water bathymetry survey along West Bengal coast (100%), Tamil Nadu coast (70%) and Andhra Pradesh (60%) has been completed successfully.

DEEP OCEAN MISSION

3. DEEP OCEAN MISSION

Ministry of Earth Sciences launched the Deep Ocean Mission for the exploration of living and non-living resources in the ocean.

Components of the above Mission are :

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 leading the vertical 1 and 5 of the Deep Ocean Mission and plays a major role in verticals 3 and 6.

3.1 DEEP SEA TECHNOLOGIES- DEVELOPMENT OF MANNED & UNMANNED UNDERWATER VEHICLES

Background

Deep Ocean is replete with non-living resources such as Polymetallic manganese nodules which are rich in manganese, cobalt and nickel, hydrothermal sulphides, gas hydrates etc. By considering the deep seabed characteristics and limitation in our understanding, the technologies required for the exploration and exploitation of deep-sea minerals are complex and challenging. Components need to operate at high pressures upto 600 bar, low temperature (< 2C) and highly corrosive conditions without the electromagnetic communication. Special materials, power sources, communication systems, launching platforms, hydraulic systems, and special cables are not commonly available and are custom made with participation of international expertise.

Deep sea technology group has designed and demonstrated unmanned underwater vehicle to operate up-to the depth of 6000m water depth and also for polar applications. Seabed crawling machines with tracks, floating vehicles, subsea drills were developed and demonstrated successfully for the deep-sea exploration. To further deep-sea research, Government of India had announced Deep Ocean Mission and Deep-Sea Technology group which is involved in design and development of 6000 m depth rated Integrated Mining System for polymetallic manganese nodule exploration and design and development of 6000 m depth rated Manned Submersible for deep ocean scientific research.

DESIGN AND DEVELOPMENT OF 6000 M DEPTH RATED MANNED SUBMERSIBLE

Preliminary design for the development of a 6000m depth-rated manned Submersible capable of carrying 3 persons with an operational duration of 12h and emergency endurance of 96h is completed and the detailed design is underway. As most of the subsystems are closer to realization, to bring awareness of complexities during integration, System Integration Review

(SIR) is undertaken in advance through three separate expert committees. The objective of the SIR is to examine the system, check for all interfaces and interactions between subsystems, and to reduce the failure possibilities to as low as practically possible. Detailed SIR documents are prepared and submitted to the expert subcommittee and reviews are conducted. The first manned ocean mission "Samudrayaan" was launched by the Hon'ble Minister of Earth Sciences Dr. Jitendra Singh in the presence of Secretary, MoES, and Director, NIOT on October 30, 2021 at NIOT.

Manned ocean mission is launched by the Hon'ble Minister of Earth Science, GOI.

(i) Personnel Sphere for shallow waters

A 25mm thick, 2.1m inner diameter, steel personnel sphere was designed and fabricated for 500m water depth. The design, manufacturing, and QC documents were submitted to the class for man-rated approval. The class, after approving the design and fabrication process, recommended carrying out an external pressure test at 600m water depth for two cycles with a holding time of 1h. Based on the class-approved test procedure, hydrostatic pressure tests were conducted at depth of 620 m in the Bay of Bengal onboard Sagar Nidhi in Oct 2021. The logged observations including the strains in 16 weld locations were submitted to the certification agency for approval. To ensure the post-hydrostatic structural integrity, sphericity measurements a Non-Destructive Test (NDT) was carried out in the presence of a DNV surveyor at NIOT. The shallow water personnel sphere is certified by DNV for operation up to 500m water depth after thorough review of the design, manufacturing documents, and pressure test reports from March 2022. This class-approved man-rated sphere shall be integrated with the submersible frame for enabling shallow water operations.

Pressure test at 606m depth, strain measurement, and Out of sphericity measurement

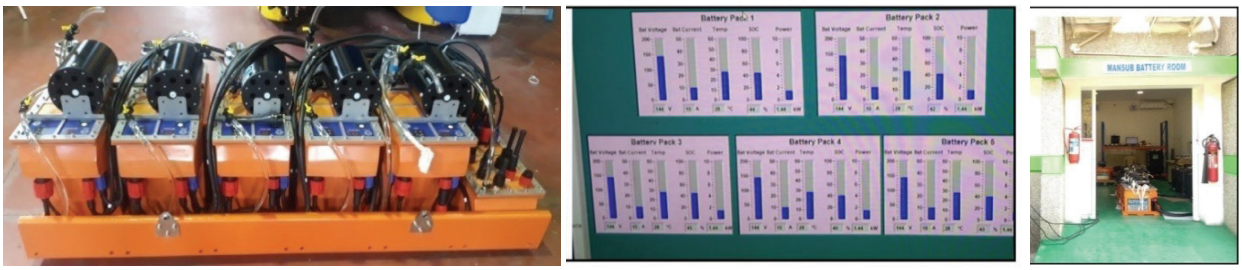
(ii) Human acclimatization trials using shallow water personnel sphere at ATF

The man-rated 500m personnel sphere is equipped with in-house developed life support systems, power distribution, data acquisition, telemetry, and communication systems which were deployed at the Acoustic Test Facility (ATF) of NIOT at a depth of 7 m with three personnel. A human acclimatization test in an enclosed environment of the 4.8m^3 volume sphere was conducted on March 26, 2022 with three personnel for 2 hours, during this time, human health parameters are monitored. Based on the experience gained, long-endurance acclimatization tests are planned.

Pictures captured during the Human acclimatization endurance test with the shallow water sphere

(iii) Subsea Batteries

The submersible is powered using 2 numbers of main batteries of 148V-50kWh and 2 numbers of auxiliary 28V-10kWh batteries. The 148V-100kWh batteries were manufactured, DNV-certified, and commissioned in NIOT by the OEM in January 2022. The charging and discharging tests were conducted on the integrated battery packs with in-house developed control software with a user interface for monitoring the performance. The procured batteries are stored inside a temperature-controlled and temperature-stabilized storage facility equipped with fire protection & safety equipment.

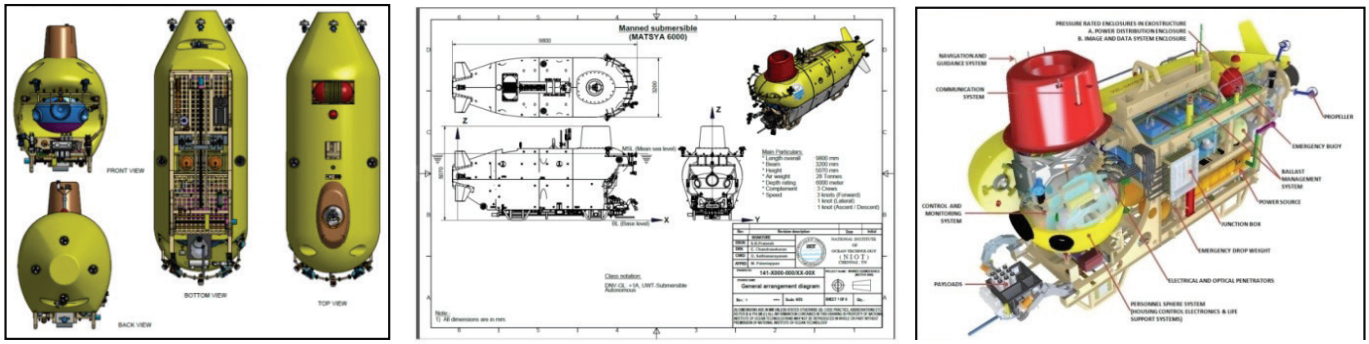


100kWh Li-Po battery commissioned User interface and storage facility

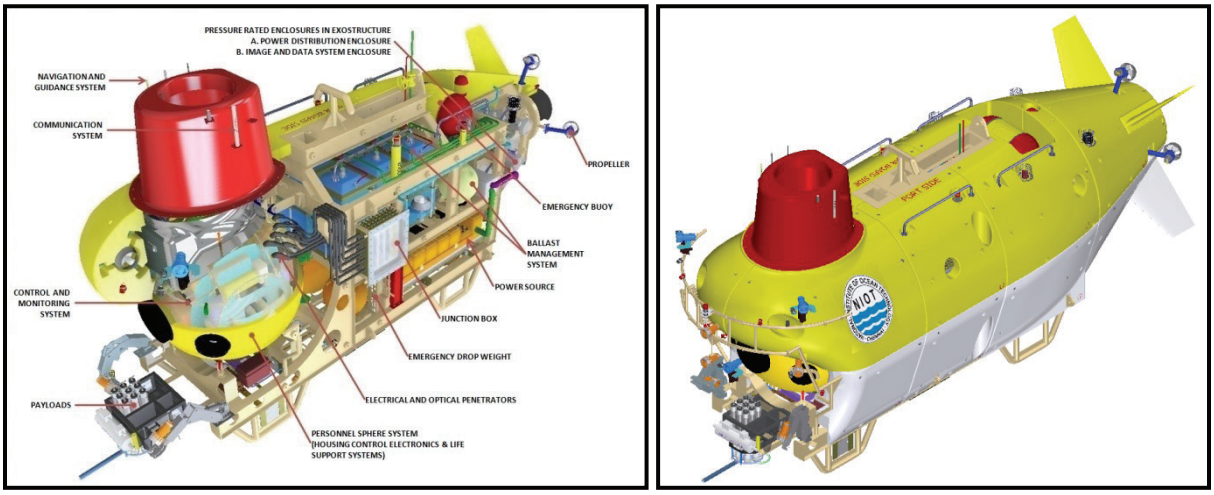
(iv) Vehicle Shape and General Arrangement

During the ongoing detailed engineering phase, subsystems were optimized as part of design iteration. They include a weight shift mechanism for trim and heel correction, increasing the capacity of the main ballast to meet the reserve buoyancy of 10% of vehicle displacement, increasing the variable ballast tank capacity, and drop weight denominations for enabling the

submersible to stop before surfacing, accommodation of emergency rescue systems, optimizing the number of pressure cases used for electrical and electronics and the size/ weight of the exo-structure Ti-alloy frame and modifying the overall shape for improved hydrodynamic performance. Based on the data provided, IIT Madras has performed detailed analysis such as hydrostatics, stability assessment for a few operational conditions, and CFD simulations to find out the terminal velocities during ascent/descent motions to understand the extent of vehicle emergence out of the water at the end of the ascent and drag estimation in different directions.



Different views of Manned Submersible CAD 3D model

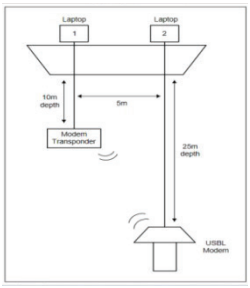


Subsystem assembly view of 6000 m depth rated Manned Submersible

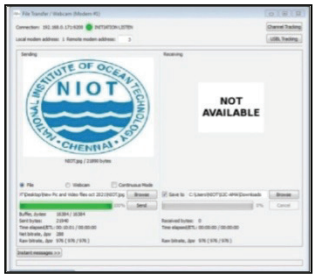
(v) Acoustic modem qualification at Open Sea

The submersible is provided with a redundant bi-directional acoustic data telemetry system for enabling data transfer with the deployment ship. The system operating at 7-17kHz with a data rate of 6.9kbps for an operating range of 12km was procured and its functionality was tested in the NIOT pond. The performance of the modem is tested at 30m depth in the open sea with the configuration described in the figure at a location in the Bay of Bengal (13°2.7670'N80°44.1351'E) on October 24, 2021 onboard Sagar Nidhi. Testing the data communication between the USBL transceiver and transponder was carried out by sending files and pictures. Further qualification tests are being planned to be held in deep waters.

Transponder deployment



Deployment Scheme



NIOT logo transmitted and received

(vi) Personnel sphere internal electronics and Pressure-rated enclosures

The electrical and electronic systems in the submersible are distributed inside the personnel sphere and four pressure-rated enclosures are mounted in the submersible exo-structure. Two power distribution system enclosures (PDE) and two Imaging and Data system enclosures (IDE) are used, each located on the port and starboard sides of the submersible. Based on this, a 3D modeling is done with the help of the binding dimensions available with the component suppliers in which the component placements are done based on ergonomic standards. A competent industrial firm is being identified for carrying out modeling, Procurement, Assembly, Integration, and Testing on a turnkey basis complying with class rules for certification.

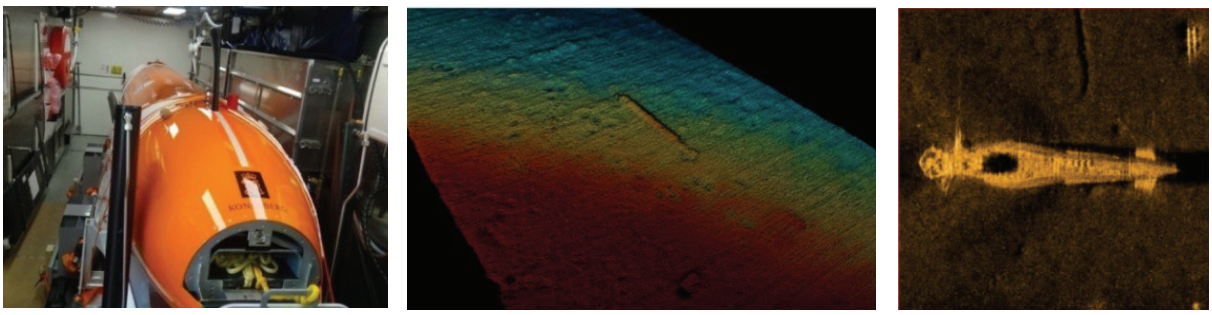
UNMANNED UNDERWATER VEHICLES

(i) Development of Remotely Operated Vehicle (ROV)

A 6000m depth-rated remotely operated vehicle ROSUB 6000 and a 500m depth-rated polar cum shallow water ROV (PROVe) were developed and are used for scientific purposes. Augmentation of High definition camera and telemetry system in shallow water ROV is completed and has been tested regarding its functionality. Based on the Transfer of Technology agreement signed with Bharat Electronics Limited further discussions are underway for vehicle development.

(ii) Procurement of 6000m depth-rated Autonomous Underwater Vehicle (AUV)

A 6000m depth-rated autonomous underwater vehicle (AUV) is procured for enabling high-resolution close seabed mapping and to carry out physical/chemical oceanographic studies. Factory Acceptance Test (FAT) was completed at about 200 m water depth in Norway during May 2021 with the online participation of NIOT, NCPOR, and NIO. Sea qualification was completed at 1270 m water depth in Norway in August 2021, witnessed by DNV and online participation of NIOT, NCPOR, and NIO. The AUV is received at NIOT in March 2022 to proceed with Sea Acceptance Test (SAT) and deep-sea mineral exploration sea trials.



AUV received at NIOT, Bathymetry, and underwater object captured during FAT

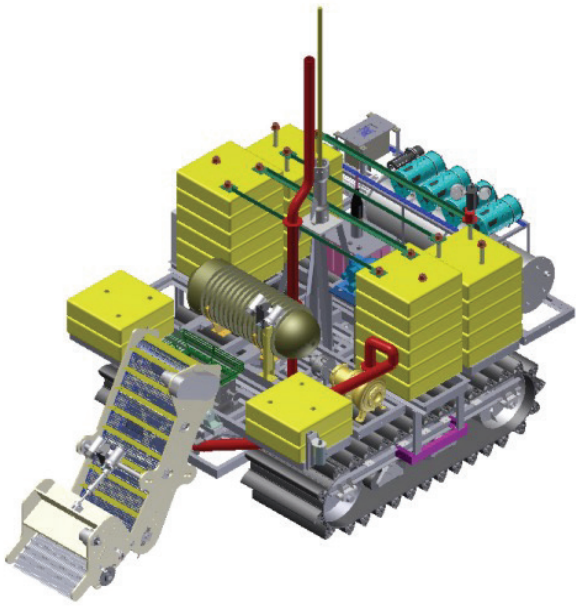
3.2 DEEP SEA TECHNOLOGIES - DEVELOPMENT OF INTEGRATED MINING SYSTEM FOR MINING POLYMETALLIC NODULES FROM 6000 M

The mandate 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 5500 – 6000 m at the Central Indian Ocean and successfully transport it to the surface, in a reliable and sustainable manner.

Background

Development of technology for mining deep sea mineral resources was part of the PMN Programme of the MoES, aimed at developing indigenous mining technology to harvest polymetallic nodules (PMN) from depths up to 6000 m and successfully transport it to the surface, in a reliable and sustainable manner. 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 generally in the Pacific and in the Indian Oceans. These nodules are rich in the principal metals such as: nickel, copper and cobalt, apart from iron and manganese and are considered to be of economic and strategic importance.

India as a Pioneer Investor in Apr 1982 along with many other countries, was allocated 150,000 km^2 of Area in Aug 1987 by the UN in the Central Indian Ocean Basin (CIOB) for survey and exploration for polymetallic nodules (PMN). Subsequently, India had a 15-year Contract in 2002 with the International Seabed Authority (ISA), Jamaica for undertaking development activities for polymetallic nodule mining: survey and exploration and undertaking test mining trials, over half of the originally allocated Area – 75,000 km^2. This contract was renewed for 05 years in 2017 and renewed again in 2022 for another 05 years, principally to develop an Integrated Mining System (IMS) for pilot demonstration of harvesting PMN from the depths up to 6000 m at the CIOB. India has focused on developing and demonstration of the deep sea mining technology in the Indian Ocean. The project is a principal component of the Vertical-1 of the Deep Ocean Mission of the MoES/GoI.

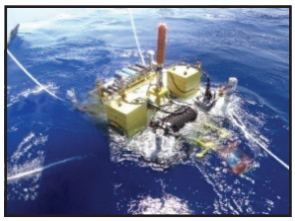


Schematic of the Mining machine with Nodule collection and Pumping System

Development of an Integrated Mining System for mining of Polymetallic Nodules from depths up to 6000m

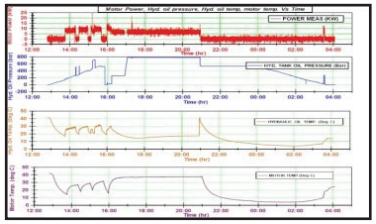
(i) Locomotion trials of the self-propelled Seabed Mining Machine, Varaha-1 at depths of 5270 m at the CIO

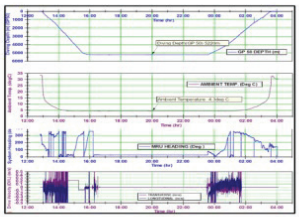
Seabed locomotion trials of the self-propelled seabed mining machine, Varaha-1 were successfully undertaken on water-saturated soft seabed soil at depths of 5270 m depth in the Central Indian Ocean (CIO) from March to April 2021. The machine was operated for over 150 minutes and covered a cumulative distance of 120 m. The trials provided valuable information on the sub-sea navigation and positioning system, controlled locomotion on soft water-saturated soil of the seabed and related sinkage, and the performance of the electro-hydraulic systems at high hydrostatic pressure and low temperatures, and handling of the mining machine during launching/retrieval operation. Incidentally, these were the deepest trials completed so far, for a seabed mining system.



Deployment of Mining Machine from ORV Sagar Nidhi

Sinkage of track belts during locomotion

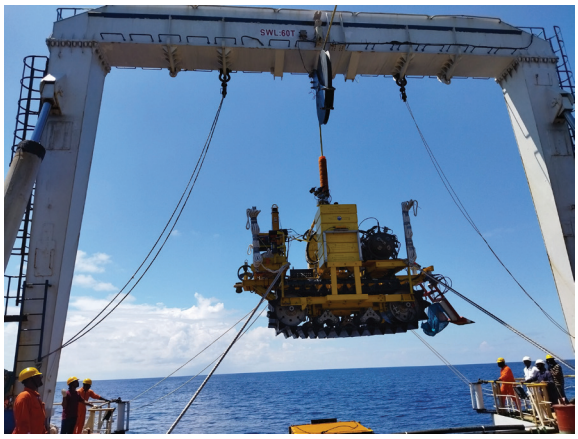




Performance parameters of Locomotion tests at 5270 m water depth

(ii) Trials of the self-propelled Seabed Mining Machine, Varaha-2 at depths of 5268 m at the CIO

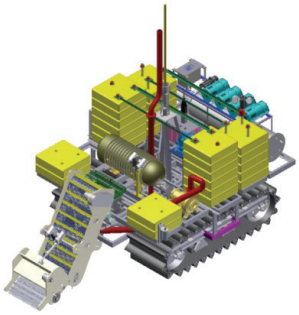
Trials were undertaken with the 4-track indigenously developed mining machine, Varaha-2, in the same area of CIO at a depth of 5268 m. These trials were successful in proving the various systems of the machine for operating under such high ambient pressures and very low temperatures. The undercarriage was developed indigenously with 4 track system with modified grouser arrangements suitable for soft sea bed soil.



Launching of mining machine -V2

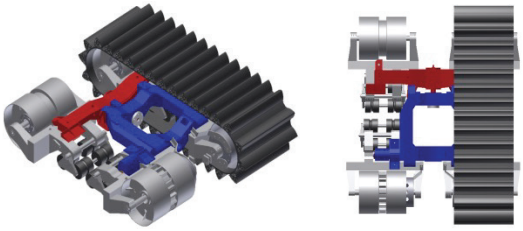
(iii) Preparation and readiness of Seabed Mining Machine for the Nodule Collection and Pumping Trials

The seabed mining machine has been extensively reconfigured, re-engineered, and augmented since the last trials in Apr 2021 to a depth of 5270 m, for reduced weight in air and minimal underwater volume (improved self-buoyancy). The chassis, superstructure, traction system, and nodule pick-up and conveyor system have been optimized and tested in the test bed. The nodule crusher, slurry feeder, and pumping system by entrainment have been tested extensively as an integrated unit. The 95kW subsea HPU and the complete control and instrumentation units have been tested in the hyperbaric chamber at 600 bar external pressure, in the simulation of the deep-water pressure conditions. The mining machine is presently integrated and ready for the scheduled trials in Aug 2022 in the Bay of Bengal before the actual tests at the CIOB in Jan-Feb 2023, to collect nodules from the seabed, crush them to smaller sizes and pump them through a 150-200 m long jumper hose as nodule-seawater slurry.

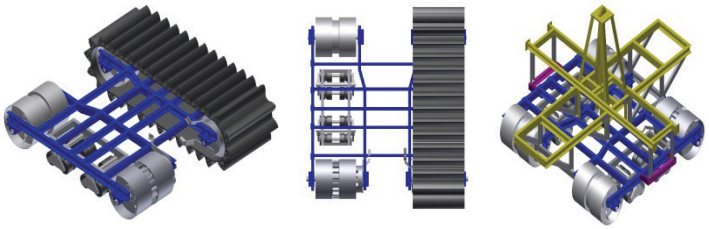


Schematic of the Mining machine with Nodule collection and Pumping System

Chassis & Structure – The old heavy chassis was reconfigured with twin-track mounting arrangements for the track belts, retaining the drive cylinder-hydraulic motor assembly and integrating with redesigned simplified frame.



Existing Chassis and cross beam system



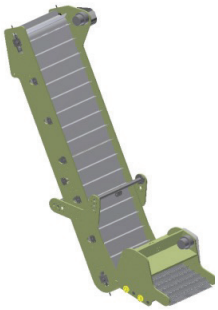
Reconfigured Chassis

The modified undercarriage system augmented with a new HPU unit was tested for locomotion and system integrity, on a sand bed at NIOT. The stability of the system was also tested by maneuvering the crawler over undulating surfaces at various speeds and higher bearing pressure

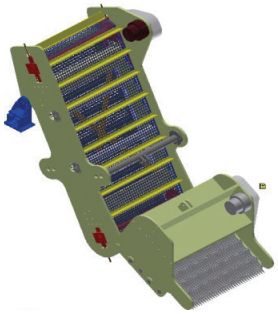
Locomotion test of new driven drum and new HPU on the sand bed

by adding weight to the system. The system was powered through a 250 kVA Medium Voltage Variable Frequency Drive (MVVFD) and 6500 m long umbilical cable (to simulate the actual conditions on board the ship).

Nodule Pick-up/Collector – To reduce the overall weight, the existing nodule collection system built in Aluminium 6061 with a weight in air of 909 kg, was replaced with Nyltron material having a weight in air of just 387 kg – giving a weight advantage of 2.3 times and buoyancy when underwater. The existing cleated belt conveyor system built-in with polyurethane material has been re-configured and replaced with a Nylon mesh with a chain sprocket – besides the weight reduction in air, it also aids in washing and reducing adhered sediment carry away with the nodules. In addition, the duplex SS tine pick-up unit was replaced with Aluminium 6061 material for further weight reduction.



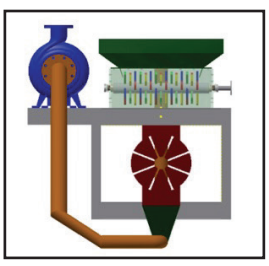
Old Nodule collection system

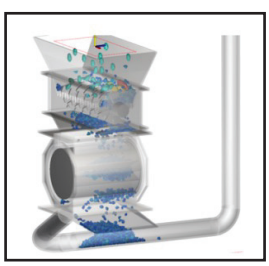


Newly configured Nodule collection system

The redesigned and developed nodule collection and conveyor system was tested under simulated conditions with actual nodules and bentonite soil, at various pull loads and collection speeds.

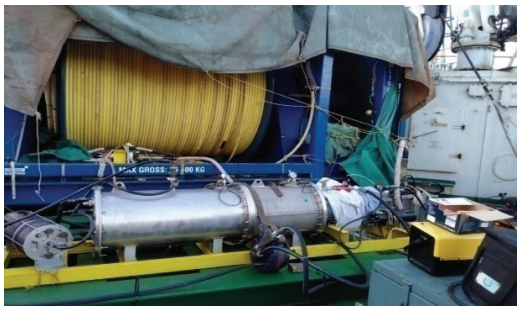
Nodule Pumping & Transfer System – The proposed Stage-1 trials of the mining machine include the vertical transfer of the collected nodules by over 50 m as a slurry and through a jumper hose of 150-200 m long. The polymetallic nodules collected are crushed to sizes less than 30mm by an indigenously designed crusher unit and fed to a rotary valve feeder. The rotary valve



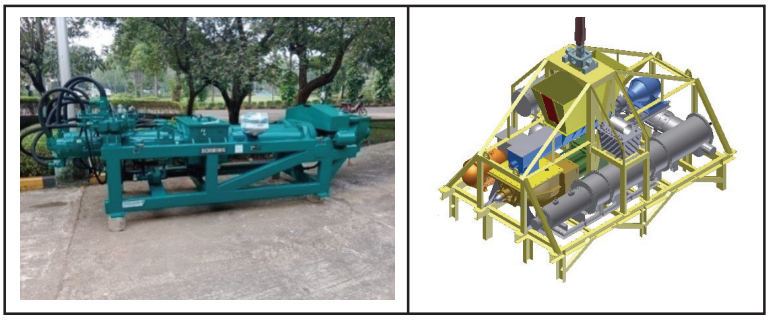


vanes are specially designed to arrest backflow under pressure, leakage of nodule slurry, and feeding into a flowing line for mechanical transfer by flow entrainment. The composite nodule transfer system has been configured and designed for weight, size, and power optimization for the subsea operation of the mining machine.

HPU testing with 7000m umbilical cable - The newly configured mining machine operable at 6000m water depth is hydraulically operated and powered by High power Hydraulic power unit (HPU). The HPU is driven by sub-sea electric motors (90-150 kW) operating at 6000V AC. These motors are operated from Medium Voltage Variable Frequency Drives (MVVFD) through 7000m long umbilical cables. The drives are customized with special filters and a voltage compensation system for operation through 7000m long cables. The cables are wound on winches installed on the ship ORV Sagar Nidhi. The complete system was tuned and tested onboard the ship with the MVVFD and the umbilical cable.



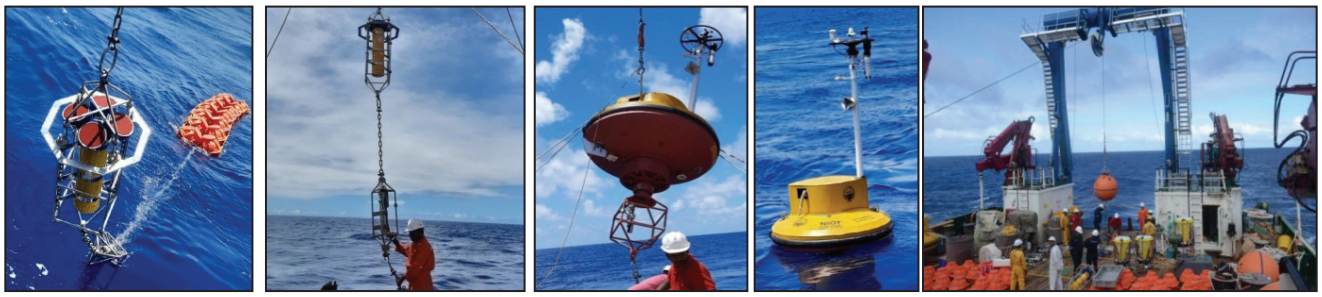
High-Pressure Pumping System - A 120 bar, 80 m^3/hr flow rate, solids twin-piston reciprocating pump, normally used for land-based applications, has been procured. This is being adapted and reconfigured for deep-sea application in a preliminary demonstration of the slurry pumping from 1000 m depth, through a flexible riser – hose. In addition, high-pressure flexible slurry hose handling and clamping arrangements are also being developed to allow easier and quicker deployment of the systems at sea.



Deployment of Moorings – Establishing Baseline for EIA

To establish the environmental baseline at the test mining site from Jan- to Feb 2023, long subsea moorings with extensive instrumentation of ADCP, current meters, CTD-turbidity sensors, and sediment traps have been deployed at the mining site and the reference area in

Dec 2021. These are deployed over depths of about 5300 m, for 12-13 months, to record the baseline data of the water column, from the 500 m level to the seabed. This is one of the most extensively instrumented and deep water subsea mooring sets deployed, as part of the project.



3.3 ENERGY AND FRESHWATER FROM THE OCEAN

The ocean energy and freshwater vertical of Deep Ocean Mission (DOM) has the following deliverables;

- 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.

Activities towards fulfilling the objectives have commenced. A tender document for identifying suitable contractors for detailed engineering design of high capacity floating OTEC and Desalination is under preparation. The proposed offshore plant will have :

- Two modules of desalination, each of 2.5 MLD and powered by the open-cycle OTEC system.
- Two modules of closed-cycle OTEC system each of 5 MW gross power.

O-SMART /
OCEAN TECHNOLOGY PROJECTS

4. O-SMART / OCEAN TECHNOLOGY PROJECTS

4.1 ENERGY AND FRESH WATER

The Energy and Fresh Water (EFW) group works on developing technologies related to harnessing ocean renewable energies and generating fresh water from the ocean. The focus is on utilising the renewable energy available in the ocean through 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 energy from the oceans 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, Ocean currents and ocean thermal gradient to generate electricity and desalinate seawater. The group's mandate is to develop cutting edge technologies that can produce potable water and generate electricity from the ocean. The group is currently working on the following activities.

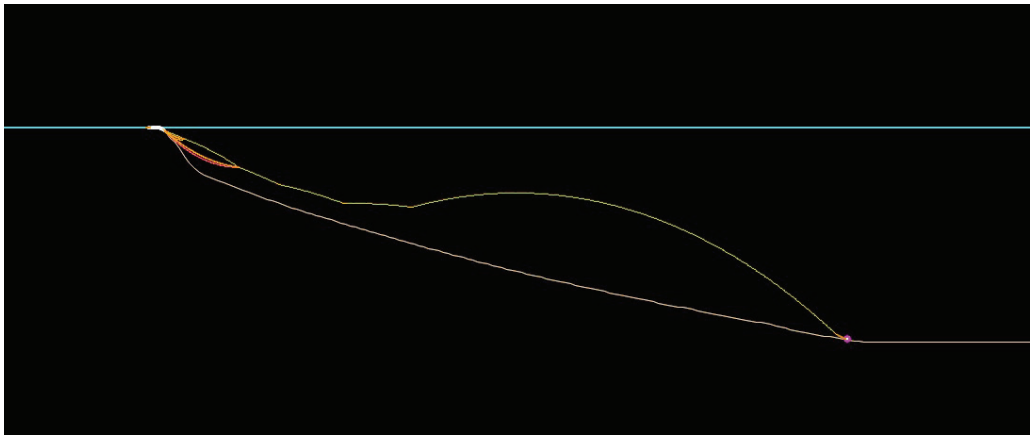
- Establishment of waste heat recovery LTTD plant in 2 modules of 1 million liters per day (MLD) capacity at Tuticorin Thermal Power Station.
- Development of turbines for harnessing energy from OTEC/Wave energy/Ocean currents, including laboratory experimentation.
- Establishment of an OTEC powered desalination plant of 100 m^3 per day capacity at Kavaratti in UT Lakshadweep.
- Activities under Deep Ocean Mission - Detailed design for a high capacity offshore OTEC powered desalination plant, including performance assessment of critical components such as deep-sea cold water conduit.

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, separate tenders on multiple work packages such as process, civil works and HDPE pipe supply and welding were floated. Bids for these tenders were received and evaluated. Contracts were signed for "Supply and Commissioning of plant equipment", "Supply and welding of HDPE pipe" and "Civil works" towards the commencement of the work. Detailed design and initial procurement works have commenced for process components.3000 m of HDPE pipeline has been extruded after successful quality checks by a third party at the contractor's premises in the presence of NIOT team during Feb – March 2022. The transportation of pipes in batches to the site has commenced. The site clearance for civil works has been completed and mobilization of the material is underway. The tests on construction materials and water samples have been completed. A ceremonial event to commence the project activities at the site was held on March 31, 2022 in the presence of The Hon'ble Administrator of UT Lakshadweep.

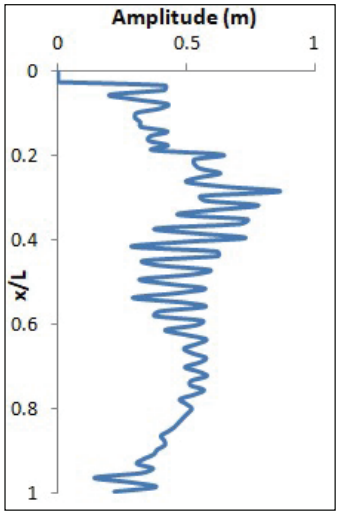
(i) Studies on long cold water pipeline

The cold water HDPE pipe is one of the most critical components of the project because of its length of almost 4 km. Since the pipeline material is HDPE, making it positively buoyant, it has to be weighed down at several segments by adding clump weights to reduce hydrodynamic loads, i.e., waves and currents. In-place analysis was carried out to ascertain the pipe configuration. Several cases were simulated to improve the pipe configuration concerning the arrangement of weights, chains, end clump weight etc. Extensive analysis are being carried out for different ocean environmental conditions of varying intensities, direction and combinations of forcing parameters like waves, currents and wind. Total weights required for different sections of pipeline were arrived using various sets of simulations considering all combinations of hydrodynamic forces. The below figure shows a feasible configuration.

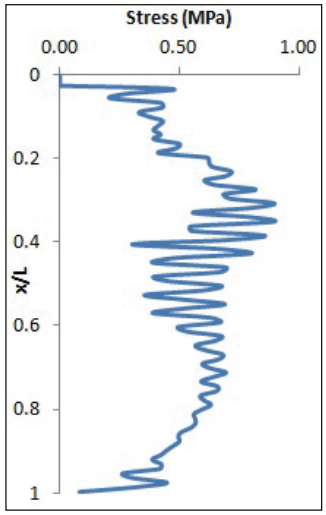


In-place configuration of the long cold water pipeline

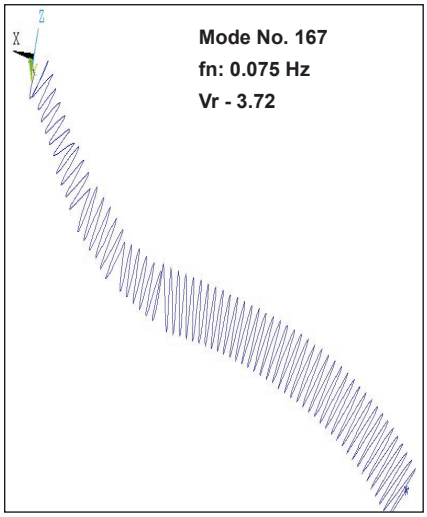
The cold water conduit is susceptible to vortex-induced vibrations due to its high aspect ratio (L/D = 4100) and inherent buoyancy (mass ratio < 1).Vortex induced vibration (VIV) analysis was carried out to estimate the pipe's VIV amplitudes, stress and fatigue damage. The pipe is restrained against translations and free in rotations at the top connection point, and the bottom



Amplitudes



Stresses



A typical mode shape

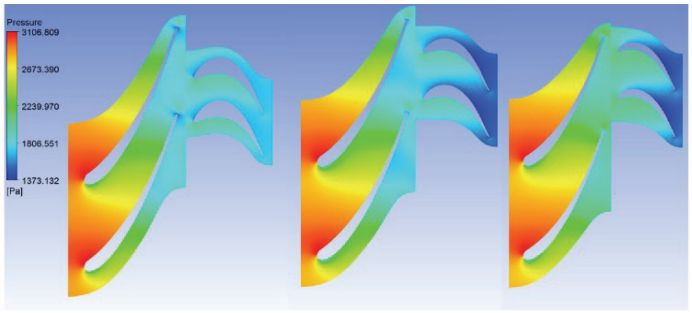
end of the pipe is free in all 6 degrees of freedom. The natural frequencies, mode shapes and curvatures of the pipe were estimated. The lock-in modes were identified based on the vortex shedding frequencies for various current speeds. The analysis was carried out in the frequency domain for uniform currents. The amplitudes and stresses in the pipe can be seen in the figure. The VIV amplitude for uniform current speeds of 0.5 m/s is found to be less than one diameter, and the maximum stress is found to be around 1 MPa, which is acceptable.

Results obtained from VIV analysis of the long cold water pipe for OTEC powered desalination plant at Kavaratti.

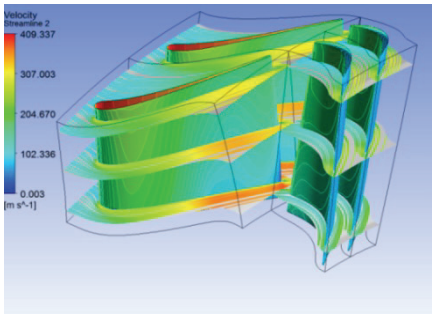
However, the analysis are being carried out for sheared current profiles. If the amplitudes and stresses in the pipe are found to be above the acceptable limits, mitigation measures for VIV will be adopted.

(ii) Design of OC-OTEC turbine

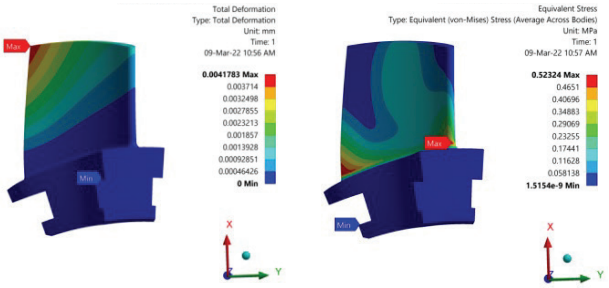
An open-cycle OTEC turbine has been designed in-house for the new self-powered 100 m^3/day desalination plant at Kavaratti. Parametric studies were carried out by varying the stagger angle, blade thickness etc., for the stator and rotor. The turbine with a pressure drop and exit velocity that closely matched the design target was selected. The variation in the number of blades further helped optimise the turbine efficiency and shaft power. The stator and rotor profiles thus obtained from computational fluid dynamic (CFD) analysis was also checked for structural strength for the pressure forces subjected on the stator and rotor blade surfaces obtained from CFD. The rotor structure was additionally checked for centrifugal load corresponding to the design speed of 3800 RPM. CFD and structural analysis results are depicted in the figure.



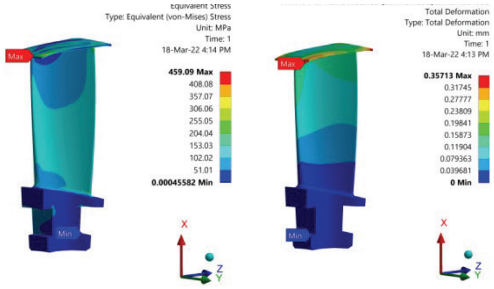
Pressure contour at the hub, mean and tip



Velocity contours at different spans



Stress and deformation of stator blade



Stress and deformation of the rotor blade

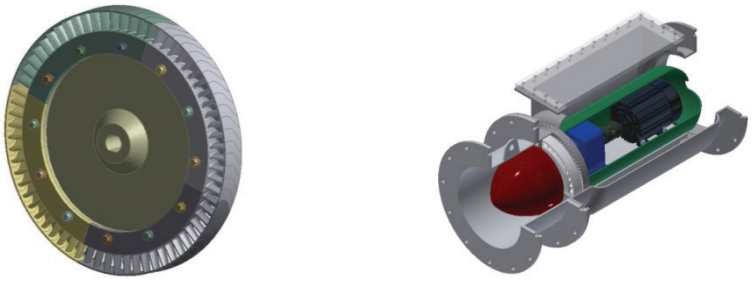
CFD and FE Analysis of the turbine blade designed in-house for Kavaratti OTEC-desalination plant

Studies at OTEC-Desalination laboratory in NIOT campus

An OTEC –desalination laboratory has been established in NIOT for R&D activities in OTEC and LTTD. The laboratory setup can operate on various modes such as, Open and Closed Cycle OTEC, OTEC Hybrid Closed Cycle, Low-temperature thermal desalination (LTTD), and LTTD using condenser reject waste heat from power plant.

The Open Cycle OTEC system in the laboratory consists of a flash chamber, power module (turbine and generator), condenser, vacuum system, freshwater tank, warm water and cold water pumps. The facility is equipped with a heater and cooler to supply water at desired temperatures to warm and cold water based on the requirement. The setup was designed to produce electrical power of 1 kW. A turbine of 268 mm diameter was designed in-house based on the electrical power requirement and tested successfully.

In addition to this, a new turbine of a larger diameter is being designed for lesser rotational speeds. This exercise aims to enhance OC OTEC system performance to further improve yield and power generation. The rotor has been designed to suit the laboratory OC-OTEC system condition. The schematic of the rotor and complete assembly with its housing is as shown.



(a) (b)

New turbine assembly for laboratory-scale OC-OTEC system

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

NIOT has planned to set up a Waste Heat Recovery LTTD technology plant in two modules, each with one million litres per day 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 power plant requirements. The other module is for producing drinking water for the nearby coastal communities.

The entire project has been divided into multiple work packages like supply, erection and testing of Process components, Civil works including the structure and warm and cold seawater piping, Supply of Seawater pumps, Supply of motorised butterfly Valves and Electrical & Instrumentation system. The tender for process components was floated, bids were received, and a successful bidder was identified. The tender for civil works, including the structure and warm and cold seawater piping, has also been floated.

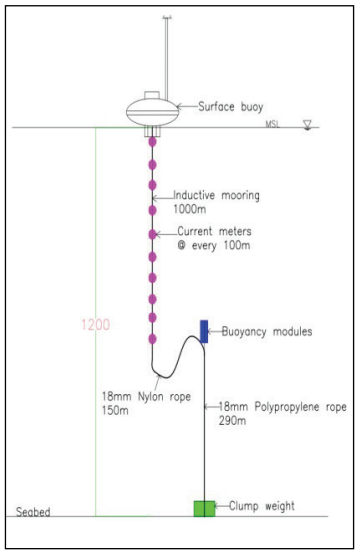
Development of wave energy devices

An all-weather floating Wave Powered Navigational Buoy (WPNB) system has been developed and demonstrated in the sea for powering a beacon lamp on top of the buoy and few ocean observation sensors using energy extracted from the ocean waves. The system communicates hourly measured parameters like wind, current, sea surface temperature, ambient pressure and

GPS location to Kamarajar Port (Chennai) and NIOT. An Android based application to access all real-time data was developed and has been implemented in the recent deployment after maintenance.

Deep-sea observation buoy off Kavaratti

As part of the group's activities towards the demonstration of critical offshore components in DOM, various site-specific studies will be carried out, including the measurement of ocean currents, temperature, and depth at regular intervals from surface to 1000m depth. The measurements will be carried out using instruments mounted on the Inductive mooring of the surface buoy at 1200m water depth. The measured data will be used for sizing and engineering design of offshore components such as deep-sea cold water pipes, mooring lines, platforms etc. A configuration of the buoy system with these sensors and inductive mooring is being readied for deployment shortly off Kavaratti, which will further help understand the long term sub-sea environment towards the installation of the pipeline for the ongoing project at Kavaratti. Sub-sensors, buoy and mooring systems have been procured and are currently under testing before deployment.



Mooring configuration with current meters

Fabricated Buoy

4.2 OCEAN STRUCTURES AND ISLAND DESALINATION

Focus of the group includes

- Development of technologies for offshore structural components
  - Feasibility studies on Fixed and Floating platform for Offshore Wind Turbines.
  - Design and Demonstration of Submerged Offshore Reefs for beach restoration at Pondicherry 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.
- Establishing 1.5 Lakh liters per day capacity Low Temperature Thermal Desalination plants in six Islands of The Union Territory Lakshadweep.

Background

National Institute of Ocean Technology (NIOT) is handling various programmes like desalination, deep sea mining, ROSUB, data buoys etc., for exploration and extracting ocean resources. These include design of marine structures, pipelines/risers, moorings in deep water and submersibles. The group addresses the need for developing several offshore components which has been felt 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 that uses the ocean thermal gradient for conversion of sea water into potable water is taken up and three such plants are operated and maintained successfully by local islanders for the past 17years in Kavaratti and 11 years in islands of Agatti and Minicoy. 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 plant Amini, Chetlat, Kadamat, Kalpeni, Kiltan and Androth Islands Islands of UT Lakshadweep

Lakshadweep islands are remote, and are facing drinking water scarcity due to increased population and tourism activities. NIOT has developed Low Temperature Thermal Desalination (LTTD) technology and established plants at Kavaratti (2005), Minicoy and Agatti (2011). The produced fresh water is being supplied continuously to local communities since commissioning the plants. The process is environmentally friendly and requires low maintenance. 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. All marine structures and cold water pipe are performing well even during extreme environmental conditions.

Ministry was entrusted with the task of establishing six more 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 environment are different in each island, the design of marine structures and cold water pipe were completed considering site specific conditions of respective island. The work for establishing LTTD plants has commenced during 2018.

Kalpeni Desalination plant generated fresh water on January 2020. Installation of five more LTTD plants with a capacity of 150 m^3/day in Amini, Androth, Chetlat, Kadamat and Kiltan Islands of UT Lakshadweep is in progress.

Views of the Sump, Trestle and Plant building of Amini LTTD Plant

Views of the Sump, Trestle and Plant building of Kalpeni LTTD Plant

Feasibility studies on fixed and floating platform for offshore wind turbine

The increased environmental awareness, energy security and depletion of land-based resources are driving the dependence on renewable energy technologies. 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 technology 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 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 data collection instrument for the period of 2 years. Structural design for LiDAR based data collection platform based on environmental and seabed conditions is completed for Kadamat Island, UT Lakshadweep. The platform is designed to be installed in the lagoon of Kadamat island at water depth of 2m having tidal range of 1.6m w.r.t CD.

Design and Demonstration of Submerged Offshore Reefs for beach restoration at Pondicherry coast

NIOT was consulted by Government of Puducherry (GoP) to work out long term strategies for management of coast. NIOT has assessed the status of existing protection measures, studied long term shoreline changes using satellite data, carried out process-based measurements in various seasons and numerical model studies. Based on these studies, a detailed hybrid solution with submerged north reef, offshore south reef and beach nourishment was suggested for restoration of lost beach. North reef was successfully implemented by NIOT and resulted in formation of wide beach and was well appreciated by the GoP, media and public.

The coastline of Puducherry was monitored for its performance through process-based measurements. The reef structure acted as substrata for marine growth attracting more fishes thereby enhancing livelihood of fishermen community. GoP also requested technical support

of NIOT for implementation of southern reef. With Maintenance nourishment of dredged sand from harbour, formation of wide beach of about 1.5km along the Puducherry Promenade was witnessed after 30 years.

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 March 2012 to till date 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.

Background

The group is currently involved in various research activities for development of sustainable coastal protection measures, shoreline management along open coasts and coastal inlets, evaluation of shoreline response to human interventions and climate change, coastal observations, developing design criteria for coastal infrastructure and marine ecology. Following projects of national interest / societal benefits with an aim of providing site specific solutions to various coastal problems is presently undertaken by the CEE group.

- 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.

Performance assessment along the Indian coast to assist in designing environmentally friendly structures for coastal protection

Shoreline changes result from alterations in sediment transport, which is attributed to (a) man-made reasons (b) natural causes. The blockage of sediment movement by man-made coastal structures influences sediment transport resulting in erosion on the downdrift side and accretion on the updrift side. Natural causes like cyclones accompanied by high waves causes severe beach loss and inundation of low-lying areas.

The Indian coastline is experiencing severe erosion at specific stretches due to natural and anthropogenic events. DISSEMINATE (Digital Information of Shore System Effects Due to Man-made Interventions and Natural Alterations by Technological Evaluation) atlas was developed by the group to record the impact of various coastal structures on the behaviour of shorelines. Atlas was developed for the coast of Tamil Nadu in the first phase.

NIOT has demonstrated beach restoration projects using innovative and environmentally sustainable methods at Kadalur villages. In addition to the demonstration projects, various coastal state governments approached NIOT to provide site-specific mitigation measures/ designs for coastal protection structures to protect the shorelines, coastal infrastructure and livelihood of the coastal communities.

Various studies undertaken as part of this project are discussed below.

Coastal Inlets Research Programme

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 and ensuring clean water quality within the closed water body. Some benefits are listed:

- Coastal Inlets are critical for exchange of water, sediment, and nutrients between estuaries/ creeks and seas.
- Serve in flood / storm water mitigation
- Enable safe keeping of small boats – especially during storms.
- Closely connected to beach stability
- Critical areas for water quality / ecological / estuarine health, locally and regionally – as they also serve as sheltered area for nurseries and breeding grounds
- Recreational opportunities for the nation and assets for the economic strength of coastal communities.
- Vital for inland navigation links.

Objective

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.

Scientific studies to enhance the utilization of coastal inlets have been carried out for three inlets (Cooum, Ennore and Krishnapatanam) and presently studies are in progress for Adyar inlet for sustainable opening and for studying pollution / toxicological impacts on marine ecology.

Adyar river mouth remains closed during the significant part of the year due to the formation of sand bars and negligible freshwater flows. A detailed scientific study was carried out to devise a scheme for the sustainable opening of the river mouth. Numerical model studies were carried out to evaluate the performance of various schemes. Desilting the river mouth followed by dumping sand towards the north of the river mouth for sand nourishment is proposed as a solution for the mouth opening and to prevent erosion.

Sustainable Mouth opening scheme for Adyar Inlet

Shore Protection measures for Poonthura coast

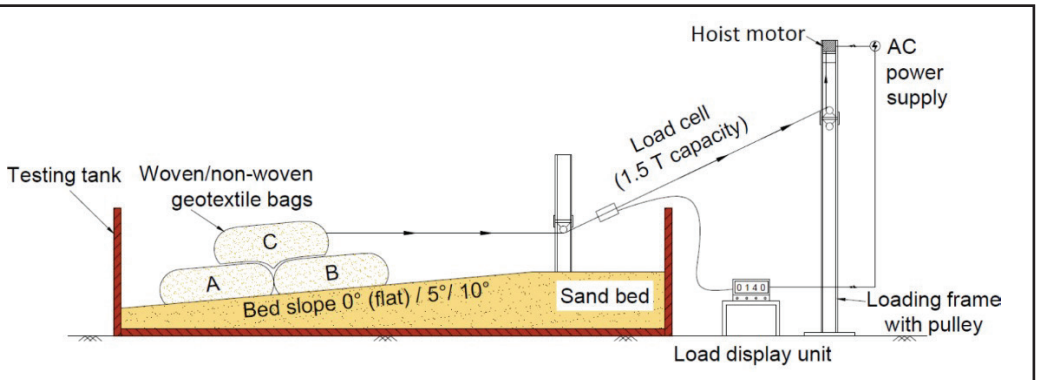
Kerala State Coastal Area Development Corporation (KSCADC) requested the National Institute of Ocean Technology (NIOT) to provide an environmental friendly sustainable scheme for shore protection and restoration of Poonthura beach, Thiruvananthapuram which is lost due to erosion. Numerical modelling study was carried out using MIKE 21 software to check the suitability of submerged detached offshore breakwater for installation at locations suggested by KSCADC. The study simulations were carried out for various configurations/gaps widths between the submerged breakwater segments such as 25m, 50m, 75m and 100m. Based on evaluation of the results, configuration with the 50m gaps provided the best solution showing development of salient beach behind the segments with negligible impact (erosion) on either side of the breakwater segments. From the study, a combined option of submerged breakwater/reef with one-time beach nourishment was proposed for the Poonthura coast.

Field implementation of the project is underway by KSCADC through a contractor with NIOT monitoring the field deployment and providing expert advice for site execution based on its experience gained from Kadalur submerged dyke project. The constructed portion of the breakwater is effective in breaking the high energy waves away from the coast thereby reducing the scour / erosion of the existing area

Construction of Submerged breakwater made of geosynthetic tubes

Stability analysis of sand filled geosynthetic tubes using laboratory scaled model tests

The geotextile tubes are generally arranged in a stacked manner to achieve the required height of the coastal protection structure. The upper geotextile tube in the stacked section is subjected



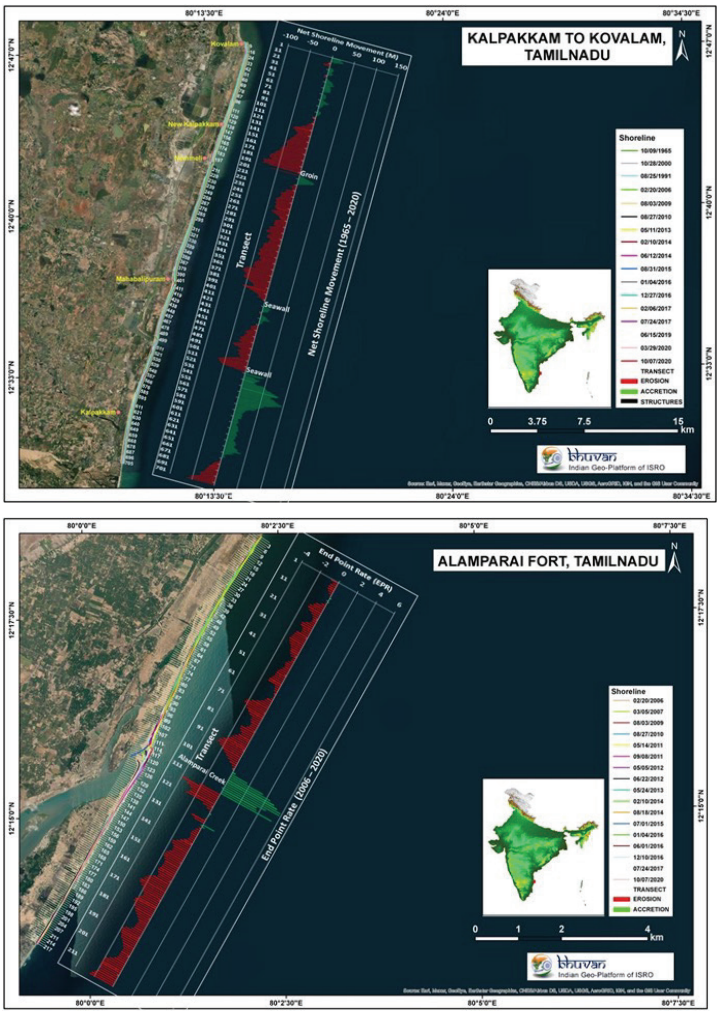
Laboratory Test Setup

to the maximum wave load in submerged breakwaters. The wave load, percentage of fill in the tubes is critical for determining the weight and the shape. Frictional interaction between the upper and lower tubes, the slope of the sea bed, gap between the supporting tubes, etc affect its stability. Laboratory model pullout tests are carried out on geotextile bags to understand the influence of each of these parameters on the stability under lateral loads. The results show that the stability of the upper tube is higher in the case of non-woven geotextile tubes compared to the tubes made of woven fabric. The resistance to lateral load is directly proportional to the friction between the surfaces, the gap between the lower tubes and the percentage of fill. Based on the results of the investigation, empirical relations are developed to estimate the lateral loads.

Development of Shoreline Response System to Structures (ShoReS)

The objective of this program is to develop sustainable coastal protection methodologies by evaluation of long term shoreline response to engineer structures at hotspots and sites with stakeholder interest. The study involves

- Statistical analysis for shoreline behaviour using historical high resolution satellite imageries.
- Field data collection and ground truthing.
- Numerical model studies to simulate the shoreline behaviour.



Typical output of Shoreline change studies using Satellite imageries

Shoreline change analysis used to assess the response of shoreline was carried out using Digital Shoreline Analysis System (DSAS) tool of ESRI ArcGIS. DSAS is an extension that enhances the normal functionality of ESRI ArcGIS software, and enables users to calculate shoreline rate-of-change statistics from a time series of multiple shoreline positions. As part of the study high resolution satellite imageries from LISS-IV and Cartosat satellites were used and impact of structures on the shoreline were evaluated.

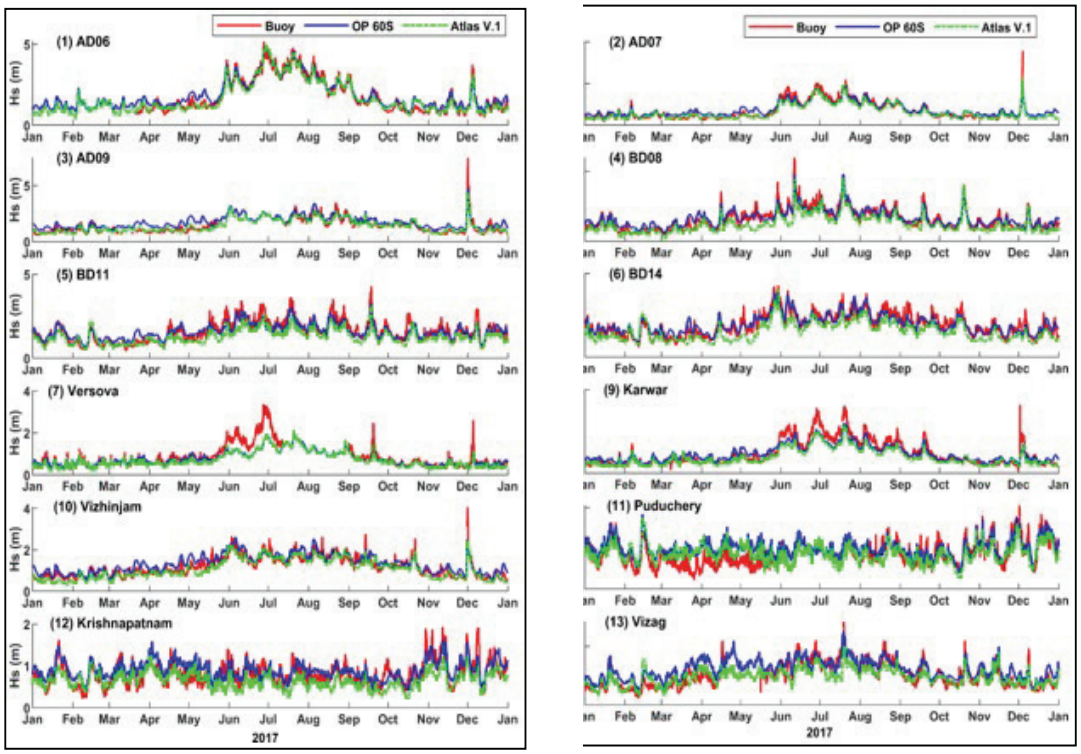
Mapping of the response of shorelines to coastal structures has been carried out for several hotpots in various states and presently completed for Ganjam in Odisha and Mahabalipuram, Alanthalai, and Alamparaikuppam in Tamil Nadu. In addition, field data were collected from selected sites and is used for numerical model studies.

Beach well technology for eco-friendly plankton-free seawater

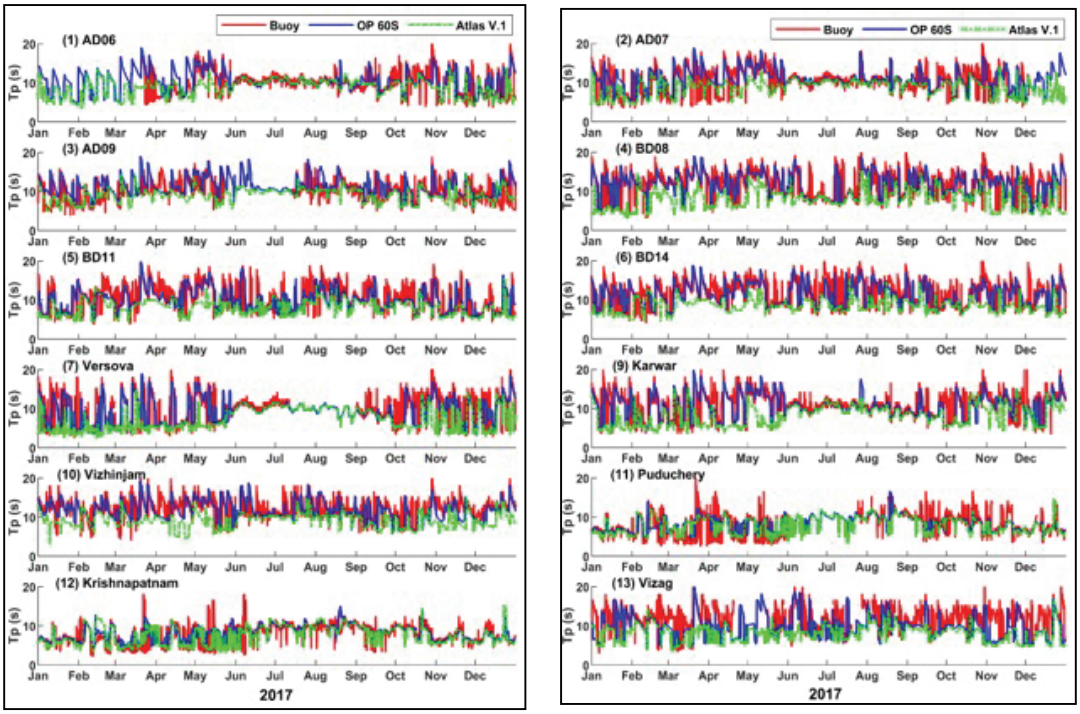
Large volumes of seawater are used for cooling water purposes in power plants, desalination plants etc., using large intake systems which withdraws plankton rich seawater. This seawater is treated with chlorine to prevent biofouling and when discharged back into the environment are often devoid of planktons thereby affecting the biological environment significantly. With an objective to reduce the impact on planktons, a beach well technology is proposed to filter the seawater which shall be plankton free and microbe free. It is found that microbe free seawater enables better aquaculture farming which is free of infections. In order to demonstrate the beach well technology, it is proposed to install an experimental plant in the nearshore waters off NIOT Seafront facility in Pamanji, Nellore. Conceptual design and layout of civil structures and intake is completed and detailed engineering designs are in progress. Preliminary water quality testing has been undertaken using this technology in the intertidal area which indicates promising results.

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

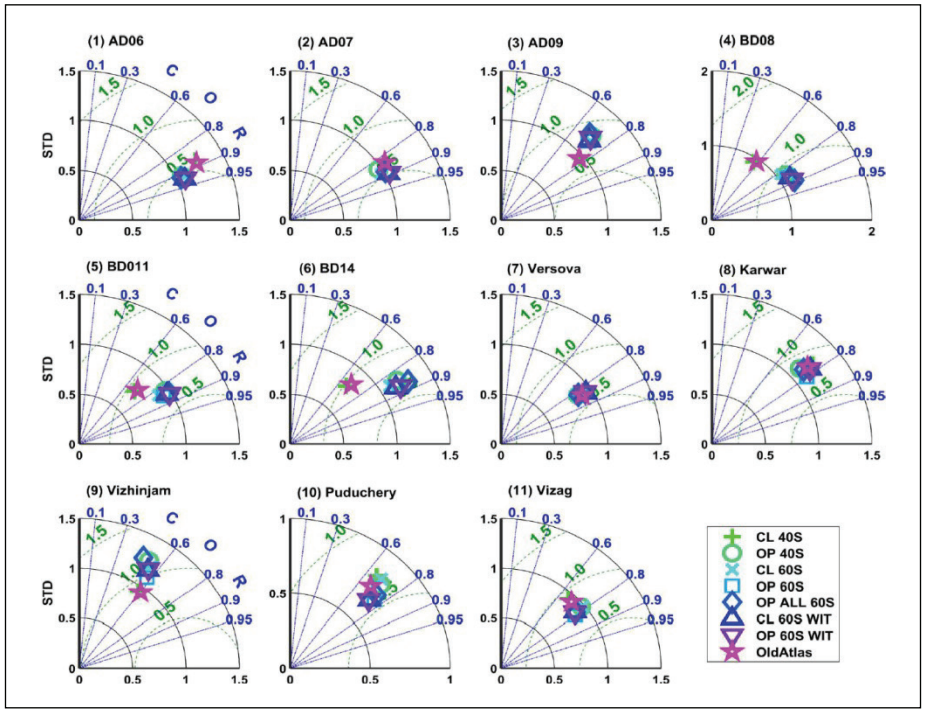
Wave model for entire north Indian Ocean is forced with high resolution wind data for the period of 1998 to 2012 and validated with NIOT, INCOIS & NIO observed wave data. Wave atlas was published during Sep-2014. The model was revised by including Lakshadweep and Andaman & Nicobar Islands. Sensitivity analysis with different southern boundary extensions such as 20^{o}S, 40^{o}S and 60^{o}S incorporating Open/Closed boundary scenarios were simulated. The sensitivity analysis results suggest that the configuration with open southern boundary having 60^{o}S extension have better match with the in-situ observation available at 12 locations in the North Indian Ocean. The correlations coefficient (R) for Observation and OP60S (Open boundary 60^{o}S domain extension) obtained up to 0.98 and the Minimum R were obtained at two southern BoB locations as 0.72 (Puducherry) and 0.74 (Krishnapatnam). Even though the configuration with OP 60S have an improvement of ~23% at Puducherry and ~13.5% at Krishnapatnam compared to Atlas v.1. In the case of peak wave period (Tp), OP60S shows a significant improvement from Atlas v.1 at three Arabian Sea (AS) shallow water locations (Versova, Karwar and Vizhinjam) where up to 137 to 396 percentages difference in correlations compared to Atlas v.1. It indicates that southern swells from the Southern Ocean have significant influence on the wave climate over the NIO and it is well represented in OP60S. Similar trend is obtained while comparing other wave parameters such as T01 and T02 with measured wave data.



Comparison results of significant wave height (Hs) at 12 locations



Comparison results of Peak wave period (Tp) at 12 locations

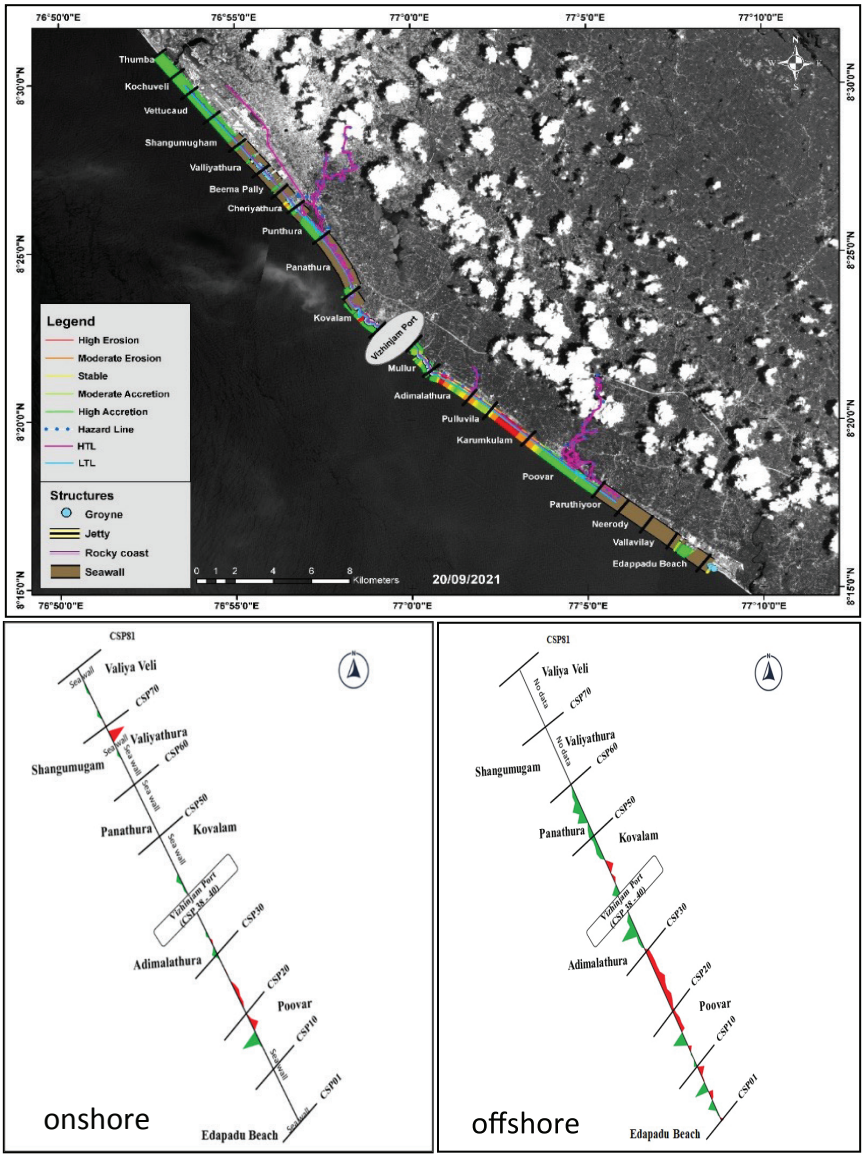


Taylor plots showing statistics for hindcast with different model domain

The coastal monitoring system has been established for Indian coast, which provides tide and met ocean parameters along the Indian coast. Operation and maintenance of coastal monitoring system network of tide stations & automatic weather stations. Data is transferred to ftp server in real time through GPRS modem. The in-house developed stand-alone program converts the ftp message to database fields at central station. The dynamic webpage has been developed to link with database to view the real time data. North Indian Ocean Tide (N.I.O.T) mobile App was developed with the observation data along Indian Ocean. The tide prediction from Jan-22 to Jul-22 at Gulf of Khambhat was updated in mobile App.

Shoreline change analysis of Vizhinjam coast using satellite images

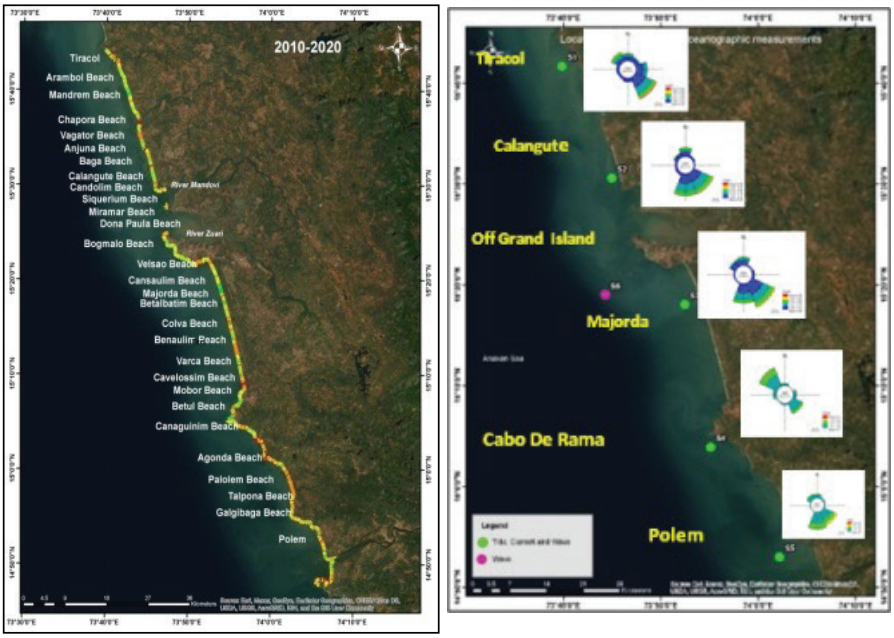
Shoreline change assessment carried out for the year October 2020- September 2021 using available high resolution (LISS IV-5m, Sentinel MSI-10m) data and corresponding beach profile analysis has been carried out. Shoreline change analysis (Monthly and Season analysis for the year 2020-2021) has been carried out using available high-resolution satellite (5m and 10m) images. Beach profile analysis (inter annual, seasonal and monthly) from September 2020 to December 2021 has been carried out. Validation of shoreline derived from the satellite image with the beach profile data. Periodic half yearly and quarterly reports comprising the above analysis have been submitted. The monthly data (oceanographic and bathymetry data) and modeling reports has been vetted and the recommendations are made. The extension of the project to carry out shoreline change analysis using high resolution satellite images (of less than 1m spatial resolution) till September 2022 has been provided. The high resolution foreign satellite images procurement and half yearly report for the period October 2021 to March 2022 is under progress.

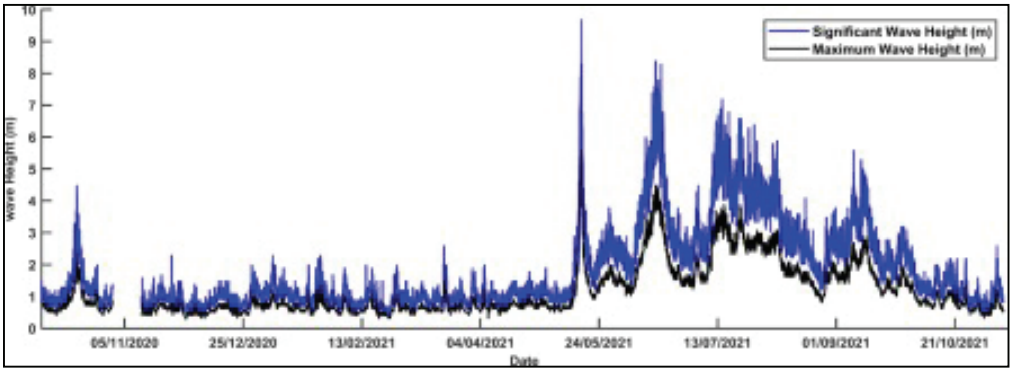


Shoreline analysis from satellite images and beach profile analysis for the fair weather period (December 2020 to March 2021)

Integrated shoreline Management plan for Goa state

Long term assessment of shoreline changes using historical high resolution imageries for identification of erosion hotspots to provide erosion mitigation measures. Site-specific hybrid solutions are being evaluated and will be finalized by numerical model studies and cost benefit analysis which shall be validated using comprehensive multi-seasonal field observations for hydrography.





Wave observation off Goa

4.4 OCEAN SCIENCE AND TECHNOLOGY FOR ISLANDS

Ocean Science and Technology for Islands (OSTI) primarily focuses on four major activities viz. Marine Algal Biotechnology, Marine Microbial Biotechnology, Open Sea Cage Culture and Establishment of Ballast Water Treatment Technologies – Test Facility with the following objectives:

- Development of mass culture, harvesting, dewatering and extraction techniques for the production of nutraceuticals from marine micro and macro algae.
- Isolation, culture, extraction and characterization of novel secondary metabolites from marine microbes for biomedical, industrial and environmental applications.
- 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.

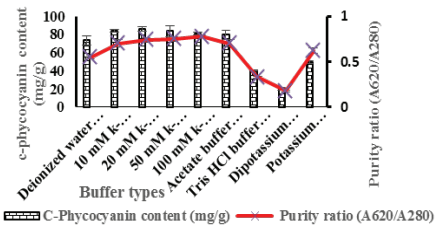
The group is also engaged in monitoring of coastal water quality in Andaman and environmental impact assessment studies for various developmental programs of Andaman Administration.

Background

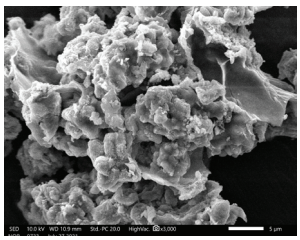
The pivotal focus of Ocean Science and Technology group of the National Institute of Ocean Technology is to develop technologies in the fields of Marine Algal Biotechnology, Marine Microbial Biotechnology and Open Sea Cage culture. Furthermore, the group also aims at the establishment of Ballast Water treatment and test facility. The group is currently working on the following activities:

- Development of technologies for the mass production of nutraceuticals from marine micro and macro algae.
- Whole genome sequencing of petroleum hydrocarbon degrading organisms and characterization of melanin pigment produced from deep sea yeast.
- Redeployment of cages for open sea fish culture for the fishermen self- help group in a new location near Olaikuda.
- Redesigning of seawater intake systems for establishment of Ballast water treatment and testing facility.
- Regular sampling for coastal water quality analysis in Andaman.

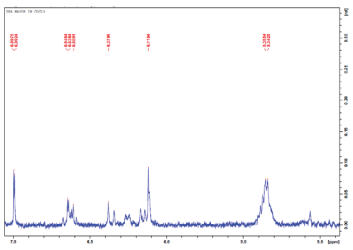
Marine Algal Biotechnology : The growth and C-phycocyanin (C-PC) production of marine *Spirulina major* (NIOT-155) was tested in different mass culture systems and a maximum biomass of 2.0g/L and C-PC of 120 mg/g were obtained in raceway. Optimized the microwave extraction of C-PC and maximum yield of 120 mg/g was recorded. A combination method of multistage ATPE + activated charcoal adsorption+ ammonium sulphate precipitation + ion exchange chromatography augmented the C-PC purity to 4.66 and a recovery yield of 42.3%. Process parameters for MAE of zeaxanthin, yet another high value pigment from marine *Spirulina* was also optimized and purified using RP-HPLC and characterized using NMR.



C-phycocyanin content and purity using different buffers



Lyophilized Spirulina biomass after MAE



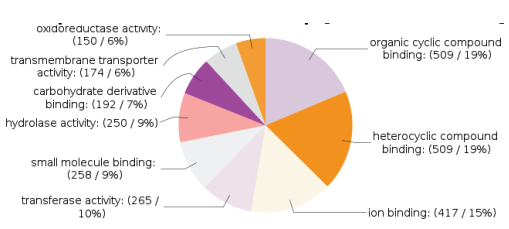
H1 NMR of zeaxanthin from *Spirulina major*

Analysis of phyto hormones extracted from *Sargassumcinerium* and *Sargassumwightii* by two extraction methods revealed that the simulate fermentation extract method gave the maximum production of plant growth promoter namely indole-3-acetic acid (IAA), indole-3-butyric acid (IBA), and gibberellic acid (GA). Mono line culture of native seaweed *Gracilariaedulis* in Chidiayatapu gave a yield of 14 kg biomass from initial weight of 3 kg in 45 days.

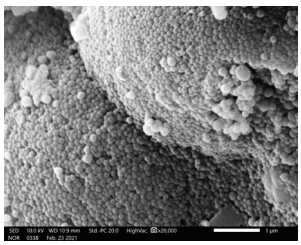
Microbial Biotechnology: Completed whole genome sequence of petroleum hydrocarbon degrading bacteria B. subtilis EB1 and the sequences were annotated for function coding genes. The genome sequence of B. subtilis EB1 comprised 3,983,989 bp with a GC content of 43.70%. Out of 4113 predicted genes, 1135 genes codes were assigned for biological process, 918 genes were assigned to cellular process and 1209 genes constitutes for molecular function. A total of 34 genes were predicted to be associated with degradation of xenobiotics.

The 16S rRNA gene sequencing and phylogenetic analysis of strain N129A28 showed closest similarity of 99.3% with *Streptomyces smyrnaeus* strain SM3501 isolated from a Saltern. The spore morphology and attachment was different from the closest *Streptomyces smyrnaeus* strain SM3501. The strain N129A28 showed 19mm inhibition zone against the methicillin-resistant Staphylococcus aureus and 17mm inhibition zone against *Bacillus* cereus. The active compound was extracted from the culture supernatant and subjected to FTIR analysis which showed 67.1% similarity with the drug erythromycin.

Streptomyces smyrnaeus N129A28



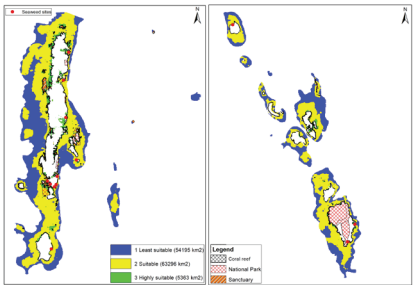
Functional annotation of *B. subtilis EB*



Micromonospora sp. Melanin- SEM

Analysis of solubility of melanin pigment form NIOT.BS23 showed better solubility in 1% H_2O_2 and 1N NH_4OH than the Sepia and Synthetic melanin from Sigma. The melanin from *Micromonospora* sp. NIOT.BS23 was readily soluble in water at pH9 while those from Sepia and Synthetic melanin remain insoluble, presenting its interesting characteristics.

Open Sea Cage Culture: Redeployment of cages for open sea fish culture was initiated for the fishermen self help group in a new location near Olaikuda, Rameshwaram. GIS tools were used to predict the site suitability for seaweed culture in the A&N Islands. Based on various models 5363 km^2 of highly suitable and 63296 km^2 of suitable areas are available for seaweed culture in the A&N Islands. The design and master layout for the proposed marine fin fish hatchery to be established at ACOSTI, Port Blair was finalized. Technical consultation for the design of artificial reefs (AR) and site selection survey off Pulicat coast for Dr. J.Jayalalithaa Fisheries University (TNJFU) was completed.

	
Rectification of open sea cages	Potential area for seaweed cultivation

4.5 ESTABLISHMENT OF BALLAST WATER TREATMENT TECHNOLOGIES – TEST FACILITY

The primary objective of the proposal is to establish land-based BWTT-TF and to test and validate Ballast Water Management Systems (BWMS) which were developed to determine the biological efficacy and environmental acceptability of the BWMS under consideration for "type approval". EIA clearance for establishment of ballast water treatment test facility at Nellore was obtained from MoEF & CC. A MoU was signed between NIOT and Central Public Work Department (CPWD), Govt. of India, for the construction of the BWTT-TF.

Background

The discharge of untreated ballast water introduces the risk of bio-invasion by viruses, bacteria, small invertebrates, eggs, cysts, and various larval forms to newer habitats. Bio-invasion has been considered as one of the greatest threats that is challenging to the health of oceans. To address this issue, the International Maritime Organization (IMO) initiated preventive measures in order to manage ballast water and sediment by ratification of the BWM Convention 2004. In this regard, the Director General of Shipping, Govt. of India, to the Ministry of Earth Sciences (MoES), Govt. of India, requested Ministry of Earth Sciences (MoES), Govt. of India, to establish a land-based Ballast Water Treatment Technologies Testing Facility (BWTT-TF) which has been planned at NIOT's seafront facility at Pamanji, Nellore Dist., Andhra Pradesh.

OSTI lab was accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL) with the standard ISO/IEC 17025:2017 (General requirements for competence of testing and calibration laboratories) as 'Testing Laboratory' under discipline 'chemical', group 'water'and material tested 'seawater'. The ballast water testing control tanks and seawater intake systems were redesigned without compromising the requirements as per the new revised guidelines put forth by the International Maritime Organization.

Seawater quality Management: Completed seasonal survey during February, July, and September 2021. Results of water quality revealed different physicochemical and biological parameters like nutrients (eg. nitrate, nitrite, phosphate, silicate, ammonia, plankton density, dissolved and sediment associated trace metals etc.) were comparatively higher at Junglighat Bay and Phoenix Bay than other sites of the Port Blair Bay.

4.6 OCEAN ACOUSTICS

The Ocean Acoustics group is focusing on the following.

- Deep water noise measurements for long term for oceanographic as well as strategic applications.
- Continuous passive acoustic measurements in the Arctic.
- Enhancement of Vector sensor array as an autonomous system towards surveillance applications.
- Upgradation and maintenance of ATF.

Background

NIOT has developed expertise in the area of Ocean Acoustics in the last 15 years and development of acoustic systems for ocean applications, ambient noise measurements in Indian deep and coastal waters and Polar regions, and underwater acoustic systems for source localization applications have been achieved. A vector sensor and array has been developed and demonstrated successfully and is being used in Indian coastal waters towards coastal monitoring. 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

The project aims to develop an autonomous ANMS for measurements in the Polar region to study ice dynamics, anthropogenic noise and biological noise through long term measurements, to understand climate change.

The Autonomous Ambient Noise Measurement System for Arctic region is enhanced with two separate systems one designed for the upper water column (top 100 m) and another for the lower water column. Each system has an array of hydrophones for characterization of noise primarily due to ice melting and anthropogenic sources. The systems will be incorporated with the Kongsfjorden IndARC mooring.

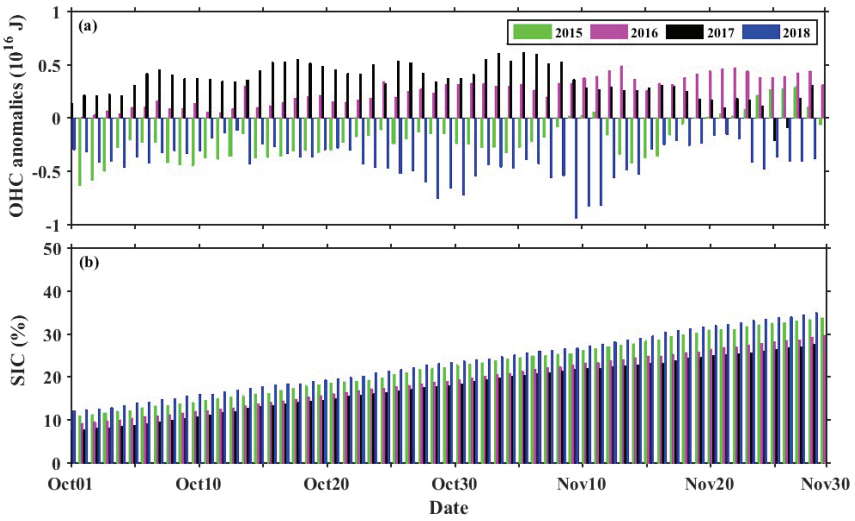
Continuous, time series year-round measurements are required for analyzing different types of ice melting and frequency of their occurrences. Towards this, a data acquisition system capable of performing with low power consumption is developed and is tested in laboratory to ascertain data coverage and to minimize data gaps. This system can record data for about two years continuously.

Data Acquisition System (DAS) configuration has been arrived at by calculating the maximum recording time for the chosen sample rate, which is based on the recording bandwidth, storage capability and current consumption. The DAS is configured and data is acquired in lab towards assessing system self noise. Testing of the assembled DAS enclosure with hydrophones in the Acoustic Test Facility has been completed prior material loading for Arctic Deployment. The materials have been dispatched to Arctic for deployment. The Ambient Noise Measurement System incorporated with IndARC mooring which was deployed in July 2019 has been successfully retrieved on August 30, 2021.

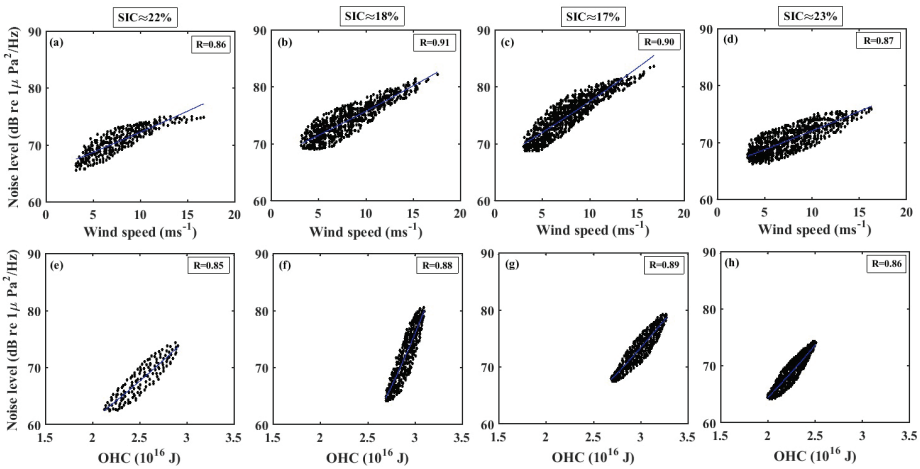
(i) Kongsfjorden - Ocean Heat Content Studies in relation to Sea Ice Concentration

The Ocean Heat Content (OHC) in Arctic fjords, is one of the key indicators of global climate change which is derived from the record of hydrography profiles. OHC is estimated in the water column of Kongsfjorden near IndArc mooring based on CTD cast and its influence on ambient noise.

Ocean Heat Content estimated for autumn season (October – November) for the years 2015, 2016, 2017 and 2018 for central Kongsfjorden. CTD data from the IndArc mooring has been analysed for this purpose. The wind speed, OHC, and Sea Ice Concentration (SIC) have significant effects on ambient noise levels in the bands 0.2-1 kHz and 1-3 kHz. Accompanying figures show linear relationship between wind speed and noise levels above 3m/s in the frequency range of 0.2-1 kHz. In each autumn period, it is observed that there is a significant correlation between wind speed along with sea ice and ambient noise levels. The noise levels and correlation coefficients



Daily (a) OHC anomalies and (b) Sea Ice concentration(SIC) at IndArc mooring in the Kongsfjorden in autumn during 2015, 2016, 2017 and 2018.

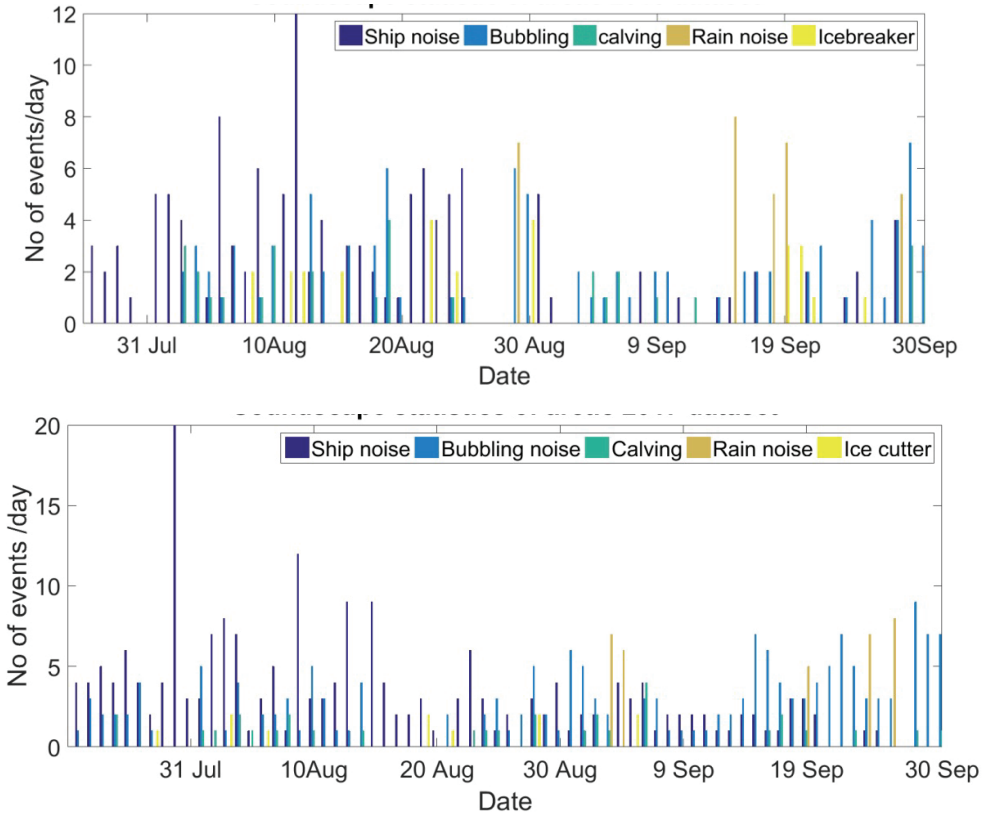


The linear relationship and correlation coefficient (R) between wind speed and averaged noise levels (0.2-1 kHz) (upper panel), and the OHC and averaged noise levels (1-3 kHz) (lower panel) during autumn 2015, 2016, 2017, and 2018. The SIC represents the value of daily averaged sea ice concentration (%). All the values of p are < 0.001.

(R) are higher during autumn 2016 and 2017. However, the noise levels and R are lower but significant in autumn 2015 and 2018. The relationship between noise levels and wind speed depends on the values of SIC. It is observed that the averaged values of SIC is low during autumn 2016 and 2017 as compared to that of autumn 2015 and 2018. The increase in wind speed leads to an increase in noise levels, and an increase in SIC shields the effect of wind speed which leads to decrease in noise levels.

(ii) Long term passive acoustic measurements in the Arctic

Sound scape studies have been carried out for summer 2016 and 2017 from hourly noise records of 3 min duration. Sources were categorized into shipping, ice noise (including bubbling and calving), and rain noise.



Soundscape statistics of Kongsfjorden, Arctic during 2016 and 2017 summer season.

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

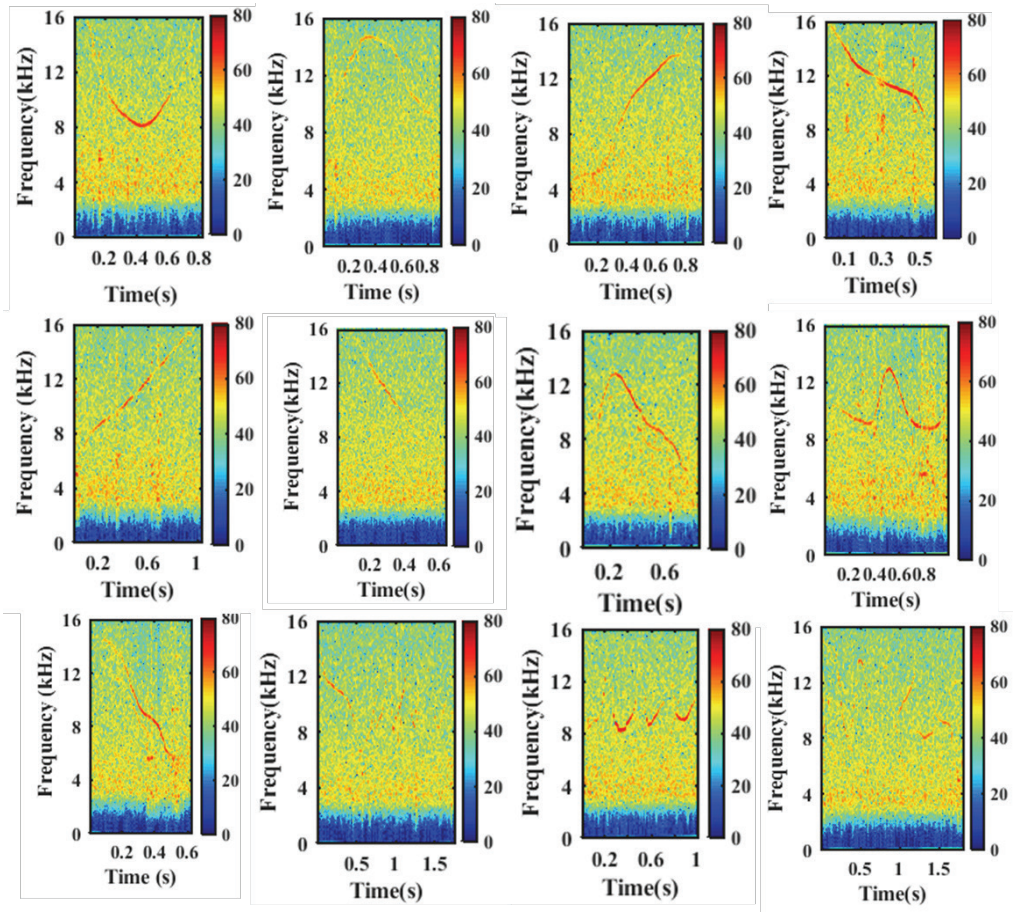
The objective is to record time series of ambient noise data in deep sea Indian Ocean region particularly to gain knowledge on noise variability and noise field in deep water, for acoustic oceanographic applications apart from strategic applications.

The DANMS deployed in Arabian Sea (AS) at AD9 (Lat: 08° 10.62'N, Lon: 073°17.04'E) and Bay of Bengal (BoB) at BD 11 (13.53 N & 84.17 E) are operational. The new DANMS that was developed indigenously in house for long term deep ocean noise data acquisition in the Northern Indian Ocean and deployed in AS was retrieved successfully. The deployed system during 2020 was

retrieved successfully during March 2022 with time series acoustic records. Time series acoustic data have been converted to ascii format and all relevant auxiliary data and metadata is stored in the required format. Currently the deep water ambient noise system is enhanced with two hydrophones and deployed in Arabian Sea in March 2022. The system is configured for 3 min acquisition every 1 hour with 50 kHz sampling and data will be acquired by two hydrophones. It is planned to increase the number of hydrophones, develop algorithm for detection of submerged vessels and implement it in the system for real time application.

Deep Sea Ambient noise measurement system in field during retrieval

(i) Acoustic measurements and wavelet denoising analysis: Identification of dolphin signatures – Arabian Sea

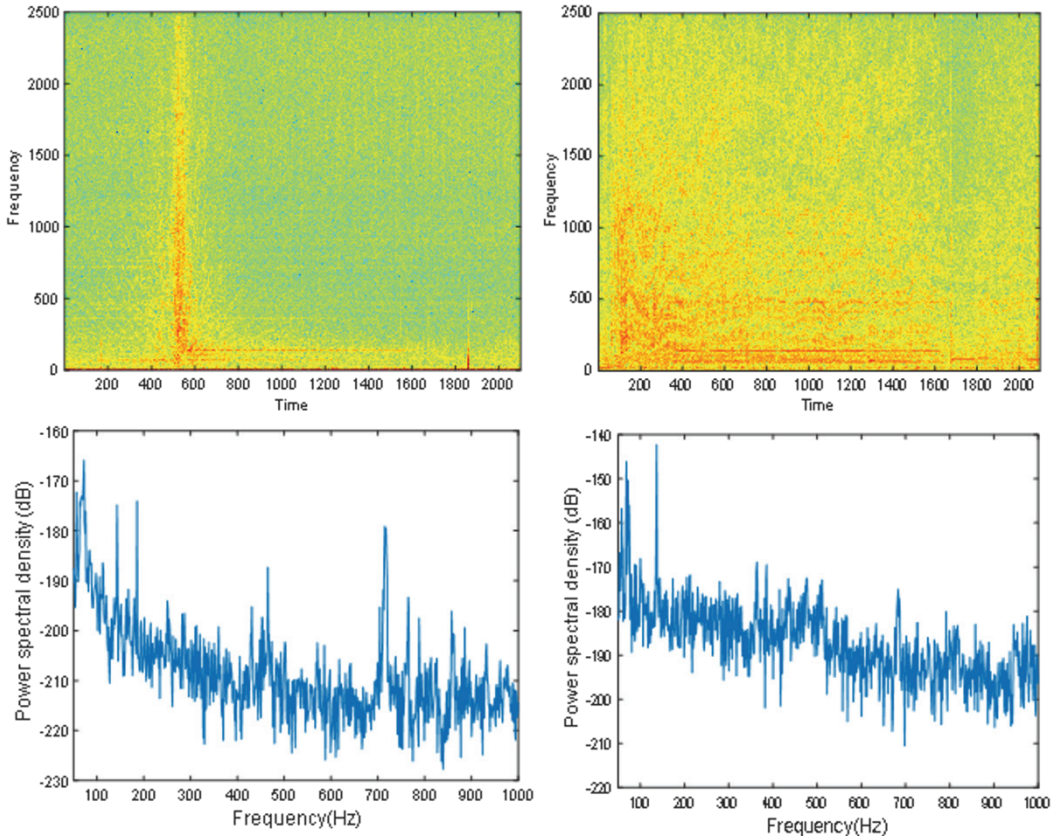


Spectrogram of different dolphin whistle signatures based on wavelet thresholding technique.

Dolphin signatures have been identified in many noise records during the month of July 2019. However, the whistle signals are contaminated with impulsive shackle noise and through wavelet denoising, the shackle noise has been removed. From the characteristic features in the spectrogram, the species is found to be bottlenose dolphins. In the time-frequency analysis, it is observed that the dolphin whistle signals are in the range of 3-16kHz.

Vector Sensor Array Enhancements towards Coastal Surveillance Applications

The objective is to enhance the Vector Sensor Array (VSA) as an autonomous measurement system for surveillance applications. Open ocean data collected by VSA during September 2021 have been analysed and it is observed that VSA has acquired many ship noise data. The ship noise sources have been correlated with marine traffic data and has been confirmed. VSA was deployed inside the Chennai harbour area for further studying the signatures of ship crossing for two weeks during October 2022.



Spectrogram (top panel) and Power Spectral Density (lower panel) of ship noise sources

Upgradation and Maintenance of Acoustic Test Facility (ATF)

Successfully completed assessment by NABL, Delhi for Electro Technical Calibration and Electronics Testing during 31st July 2021 and 1st August 2021. ATF is extensively utilized by internal groups such as Sensor systems, Deep sea technology, Ocean Electronics, Energy and Fresh water groups of NIOT. External users such as Tata Advanced Systems Ltd, Bangalore, National Physical and Oceanographic Laboratory, Kochi and Indian Institute of Technology, Delhi have availed ATF for calibration of hydrophones, and system performance testing.

4.7 MARINE SENSOR SYSTEMS

The group focuses on :

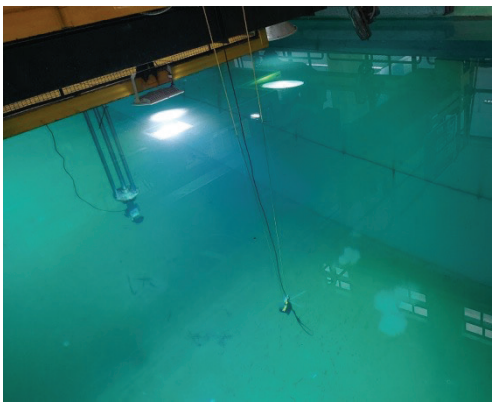
- designing and developing Indigenous Underwater Acoustic Telephone (UAT) for manned submersible operating at 6000m depth,
- designing and developing indigenous underwater acoustic imaging systems and allied technologies,
- designing and developing wide band underwater acoustic transducers and hydrophone arrays,
- and establishing and maintaining a test facility of excellence to provide support for various projects of NIOT.

Background

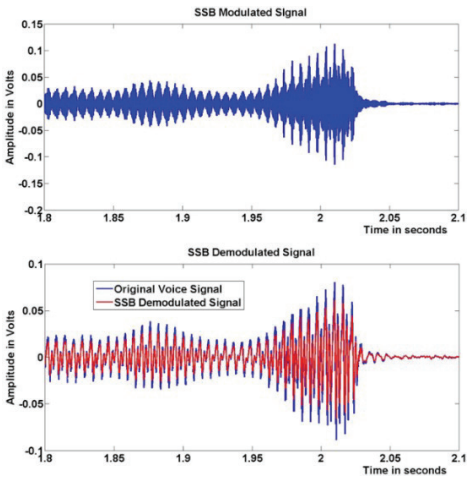
Acoustics is the only reliable technique for long range underwater communication and also underwater remote sensing/imaging from world war time till now. With a vision for indigenous technology development for self reliance in underwater sensors and sonar systems, Marine Sensor Systems group was established in NIOT. The group has successfully developed indigenous underwater acoustic transducers and systems and the group has been granted a number of patents as well as addition to the 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 Navaratna Public sector units like Bharath Electronics Ltd (BEL, Bangalore) and has an MoU with BEL for products of mutual interest.

Development of Indigenous Underwater Acoustic Telephone (UAT)

Underwater Acoustic Telephone is a system for underwater voice communication where acoustic waves carry the energy since light waves do not travel much in the water medium. Initially,



Transducer setup for UAT communication during ATF test



Transmitted and received voice signals during proof of concept

a prototype of voice communication technology was demonstrated using Single Sideband Suppressed Carrier (SSB-SC) analogue modulation technique in the Acoustic Test Facility (ATF) for a 500m manned submersible sphere.

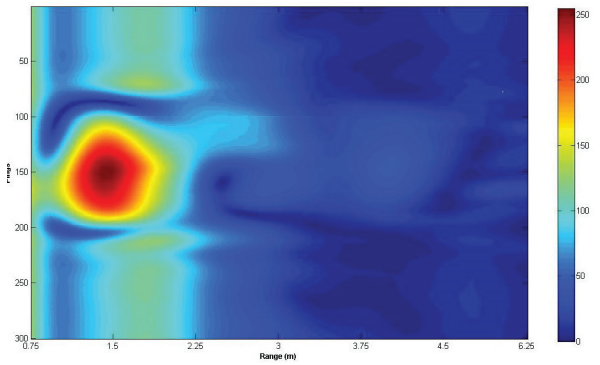
Acoustic waves are the only means of communication for both long-range (6000m) and short range (shallow water) applications. The acoustic telephone finds its application for voice communication between deep water manned submersibles and surface ships.

Underwater voice communication can be realized using either analogue or digital modulation techniques. Analogue modulation technique is commonly used in commercially available acoustic telephones, and companies do not generally supply digital modulation for all purposes, especially for deep-sea applications. SSB Modulation was implemented with a carrier frequency of 12.5kHz. Proto type hardware units have been fabricated and integrated with 500m human sphere. GUI based processing software has been incorporated with a laptop and two-way voice communication was tested in the laboratory. Vocoder based voice compression technique, LPC10 algorithm has been developed with 2400 bps and performance enhancement is in progress.

Development of Indigenous Synthetic Aperture Side Scan SONAR (ISASS)

The project's objective is to design and realize a sonar that can provide high-resolution images (decimeter level) of the sea bed to identify and detect objects on the sea bed and sub seabed with range independent resolution. For proof of concept of synthetic aperture side-scan sonar, a low frequency range (4-12kHz) 2x5 transducer array has been realized with indigenously developed NIOT-BEL transducers. After bringing out jointly developed prototype to the production level, these transducers have been supplied to NIOT by BEL-Bangalore. The array has been tested in Acoustic Test Facility (ATF), NIOT for performance evaluation. Subsystem assembly and proof of concept has been successfully carried out in the laboratory.

(a) Assembled Prototype ISASS



(b) Image of hollow sphere captured in ATF

The above figure (a) and (b) shows the assembled prototype ISASS and the image of hollow sphere captured during ATF test respectively.

4.8 OCEAN ELECTRONICS

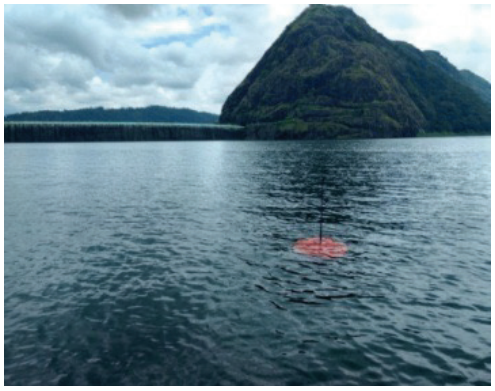
Ocean Electronics (OE) group functions with an objective and focus towards the development of new ocean observation technologies / systems to improve Ocean data collection and Ocean monitoring and also to address the requirement of satellite communication systems for ocean observation platforms. The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

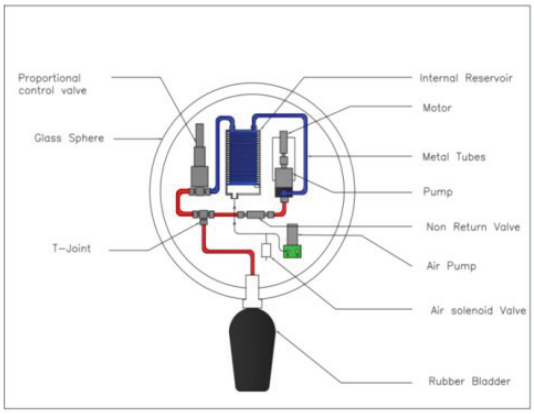
Background

Currently the group is involved in the development of Deep sea autonomous underwater profiling drifter (D-AUPD), Sea Glider, Drone based Ocean Data collections, Open sea fish cage culture technologies, Development of Phase changing material (PCM) based Thermal engine for ocean profilers, INSAT based Drifting buoys, Ship based C Profiling system. The development of sensors (temperature & conductivity) and also Geostationary/Polar satellite payloads for Ocean observation systems with the support of ISRO. OE Group is actively involved in establishment of Marine Incubation facility (MAGIC) – the Ocean technology Incubator at NIOT which will encourage and attract start-ups in the field of Ocean technology. The necessary infrastructure and other value added services will be setup. This initiative will be in line with the Make in India and Entrepreneurship development program objectives of Government of India.

Deep Sea Autonomous Underwater Profiling Drifter (D-AUPD)

500m workable Deep Sea Autonomous Underwater Profiling Drifter (DAUPD) is developed in-house using 1000CC variable buoyancy engine which suits for Bay of Bengal operations. Proto models tested for basic functional cycling test and trials carried out by deploying the unit up to 110 m depth operation at underwater acoustic research facility (UARF) of NPOL in Idukki, Kerala. Pre & Post ballasting and weight trimming of two DAUPD systems were carried.



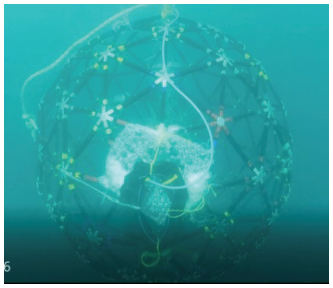


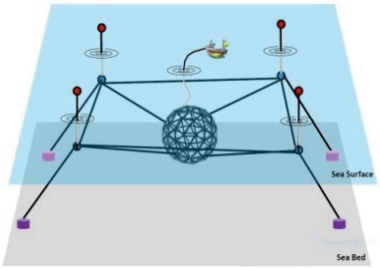
D-AUPD – Field testing at Idukki Lake – Variable Buoyancy Engine Schematic

Float mission cycle test was carried out with simulated water column in the hyperbaric chamber for observation of system performance at different sequence of operations and qualified for field deployment. RF telemetry antenna (5000m operation) for DAUPD system is also developed with the support of local industry.

Open Sea Fish Cage Culture Technologies and Systems

Development of open sea fish cage culture system is initiated and development, testing and qualification of rigid type spherical open sea fish cage culture systems are in progress. Two metre submergible spear type fish cage with automatic fish feeder mechanism has been developed and demonstrated in Andaman Islands. This is the suitable method to increase the fish farming especially during adverse weather conditions with minimum human intervention. Detailed engineering design and analysis was carried out for 12 m dia sphere type cage using ANSYS ORCAFLEX design tool.



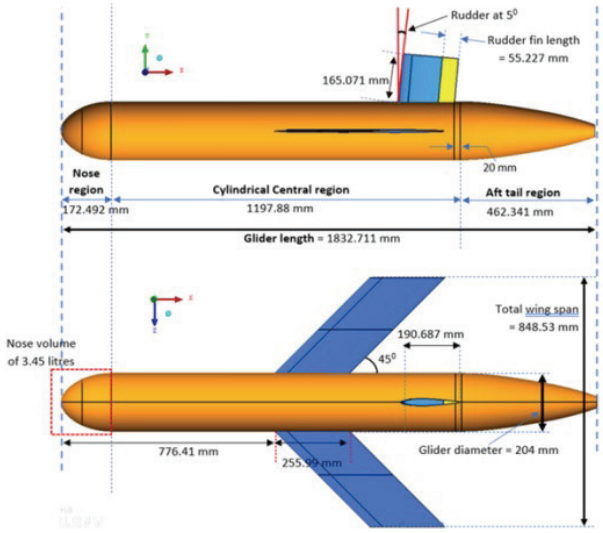


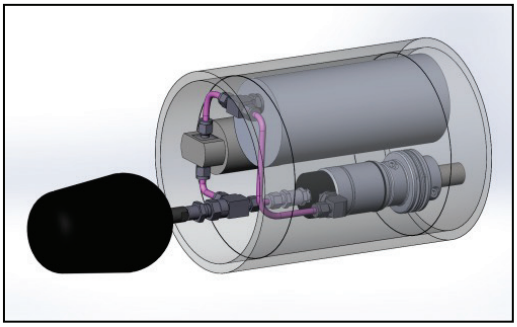
Components of fish cage and ATF test and the general schematic of fish cage deployment

Sea Glider

The deep sea observation is the new frontier for mining, oil exploration, and other industrial activities as it crosses the continental shelves to several miles beneath the ocean surface. However, this also results in impact to the environment and requires constant monitoring. In order to provide high spatio-temporal observation in the deep sea, it is proposed to develop a deep sea glider.

- Two underwater gliders procured by INCOIS were ballasted at NIOT facility to match the Northern Bay of Bengal regime.
- Gliders were tested off Chennai coast during first week of February 2021.
- Indigenization of underwater glider is initiated and procurement and testing of subcomponents are being carried out.
- Design of variable buoyancy engine for Indigenized Glider is in progress.

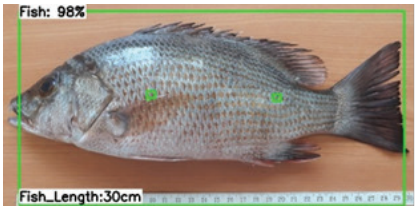


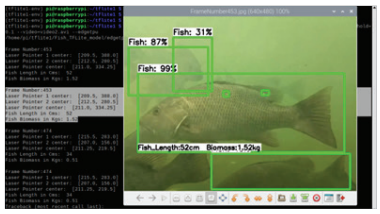


Schematic view of Sea Glider & Variable Buoyancy Engine (VBE)

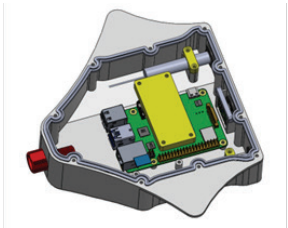
Biomass Estimation Device to Estimate Fish Growth

Internet of things (IoT) based biomass estimation technique has evolved in calculating fish growth inside the open sea fish cage. This technique uses an underwater camera with two laser pointer mechanism along with cognitive algorithm to estimate biomass. The prototype unit was tested at CIBA (Central Institute of Brackishwater Aquaculture) facility at Chennai. The fish images were captured over a period of time and image sizing and quantification has been arrived at using standard methods.





Machine Learning based Biomass Estimation Technique

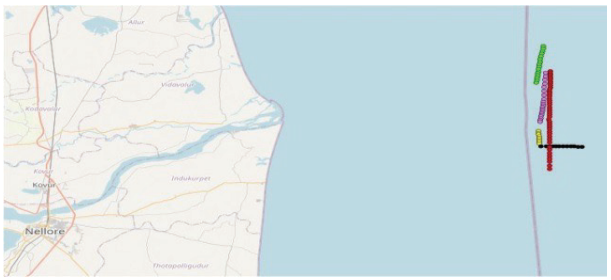


Modular schematic of Biomass estimator unit

The frame contains multiple detection of fish with different confidence levels at 99%, 87% and 31%. The frame having fish with dual laser pointers are considered for computation of the Length and Biomass. Demonstration and qualification of Bio-Mass estimation device is in progress.

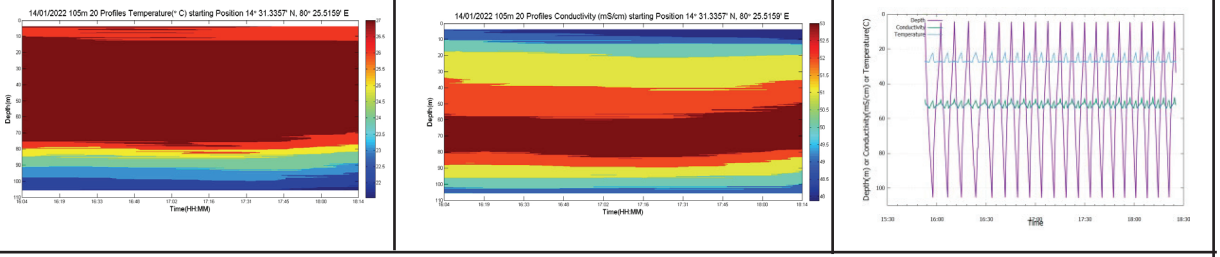
C-Profiler

The C – profiler is designed using a towfish which carries conductivity, temperature and depth (CTD) sensors as payload collecting shallow water data is vital for ocean predictions. The advantages of this profiler system includes the possibility of real-time on-board data retrieval while the vessel is on the move without lifting the probe to deck and swift changes of sensor payloads on profiler head. Firmware for data acquisition and winch for cable pay-out and retrieval is procured and few field deployments and data collection is performed. Qualification of C-Profiler system with user agencies participation is scheduled. The results of the recent field deployment and capture of Temperature and Conductivity contour plots track 2 with 20 profiles is as shown.



Track 1: 13012022 105m (6 profiles)
Track 2: 14012022 105m (20 profiles)
Track 3: 15012022 85m (5 profiles)
Track 4: 15012022 85m (10 profiles)
Track5: 16012022 105m (8 profiles)

C Profiler trial cruise carried out with 5 tracks during 12th – 17th Jan 2022



Track 2 Conductivity, Temperature contour plots and real time plot onboard

Adapting the Drone Technology for Marine Applications

As part of adapting the Drone (Unmanned Aerial Vehicle) technology towards marine applications, group has recently demonstrated the functional utility of Drone for various marine applications such as Ocean vertical microstructure data collection, Sea water sampling under Environment Impact Assessment (EIA) Studies and Beach topography and High tide mapping works etc.

a. Ocean Data Collections

The autonomous measurement devices such as CTD sensor / any other sensor and its necessary payload including the electronic gadgets, telemetry and battery pack weighing around 7 kg is attached with Drone and flown over the water body. The field dry test as well as the dip test were carried out by immersing the CTD sensor system to the depth of up to 1 m in a static water body (lake). The drone's functional behavior was observed when attached with the payloads. In this test drone has been configured into a Lock Position mode during every measurement / location for more than a minute and the data sets were relayed using Wifi telemetry. The data collected from the CTD sensor sampling is received, plotted online and updated in a handheld device.

The static and dynamic stability of the drone at various speeds were studied during lifting and hovering.

Ocean data collection using Drone mounted with CTD sensor & other instrumentation payload – Functional Demonstration at water front

b. Sea Water Sample Collection

Suitability of drone for sea water sample collection using an automatic water sampler was demonstrated at Chennai Coast. Drone carried the sampler which is set for 1m depth with equivalent pressure range in to the sea, dipped in 1m water depth for sea water sample collection.

Automatic water sampler is carried by Drone

c. Beach Topography & High tide mapping

Beach topography and high tide line mapping was carried out using drone fitted with 20 Megapixel HD cameras, near Utthandi coastal area. The image of beach topography and high tide line map derived from drone technique is as shown.

Beach topography with High tide mapping using drone

4.9 TECHNOLOGY FOR GAS HYDRATES

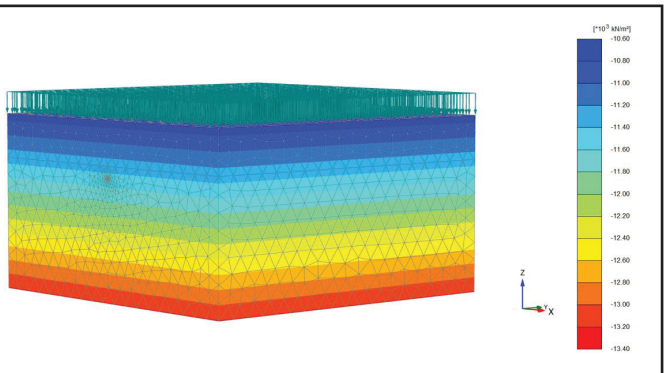
The group focusses on development of technology to explore methane hydrates from the continental margins of India and to develop laboratory facilities along with simulation techniques towards extraction feasibility approach for the utilization of the clean energy in an environmentally safe manner.

Background

Gas Hydrates are naturally occurring, solid compound containing mainly the methane gas and water in clathrate form. Gas Hydrates are stable at low temperature and high pressure environment and at Standard Temperature and Pressure condition (STP), 1 m^3 of methane hydrate shall contain 163 m^3 of methane and 0.8 m^3 of water.

Ministry of Earth Sciences is working on basics of gas hydrates to develop expertise & infrastructure in the country to study the gas hydrate deposits in the marine settings. Technology development for gas hydrate research is handled by NIOT-MoES and the science components are dealt by CSIR laboratories.

The geo-mechanical-based study is performed by combining the spherical dissociation concept and the formation of the cylindrical shape concept to observe the subsidence at the sea floor of the KG basin gas hydrate reservoir. The finite element model using PLAXIS 3D software was performed for 3 scenarios and the maximum subsidence was observed as 0.105mm at the sea floor when the tunnel diameter was 4 m at 50mbsf. The simulated subsidence data showed negligible changes in the seafloor, thus production can be efficiently carried out without disturbing the deep-sea floor environment. Refurbishment of the Tool arm assembly, Mast assembly was completed, and Autonomous Coring System was tested for its functionality to proceed for the sea trial.



3D Finite Element mesh with interstitial pressure condition

4.10 SEAFRONT FACILITY

The group is focused on creation of a world class Seafront Research Facility (SRF) to enable activities in development and testing prototype systems, validation of indigenously developed marine systems in the ocean environment and also to undertake programs connected with NIOT research groups.

Background

To establish Seafront Research Facility Subsequent to the grant in aid, for Rs. 14.74 crores received from Ministry of Earth Sciences (MoES) during March 2007, NIOT has acquired about 153 acres of land, in Nellore District, Andhra Pradesh (A.P) through A.P, State Government at SRF site in Pamanji village and 58.69 acres at FACT site in Chittedu Village, Nellore.

Master plan

A master plan has been prepared envisaging the 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 September 2018.

Pre investment activities

To secure the acquired land and to have essential facilities and immediate test facility, the following infrastructures are built through CPWD and these facilities were taken over during 2018. Chain link fencing, Security building, Race way pond for Algal culture are constructed at seafront site of Pamanji. Compound wall, Project site office, Security building, Security posts are constructed at Chittedu site of NIOT.

Test Facilities/ infrastructure

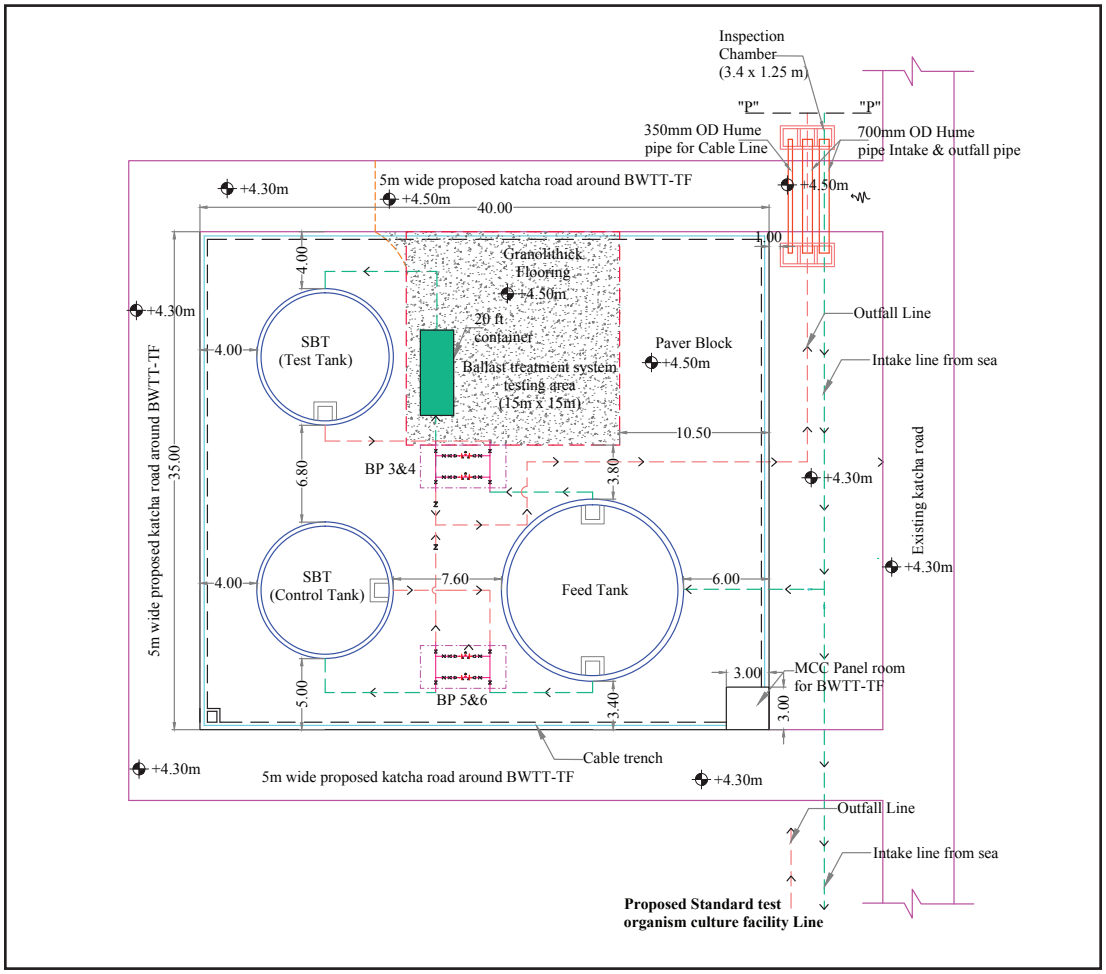
It is proposed to establish Ballast Water Treatment Technologies Test facility (BWTT-TF) at Seafront site, Pamanji, which consist of RCC tanks, pumps, pipelines and standard test organism culture facility. A pipeline trestle is proposed, which will accommodate the various field operational requirements of NIOT along with the seawater pipelines for BWTT-TF.

At present design and detailing of BWTT-TF comprising of RCC tanks, ballast pumps, and pipelines are completed. Pre tender activities are in progress. CRZ approval has been obtained from MoEF & CC - July 2017 / January 2019 for pipeline trestle.

(i) Design of BWTT-TF

Large diameter RCC tanks as described below are required to be constructed on land to store seawater and to verify the performance of ballast treatment system as per IMO norms. The Seawater that is to be pumped from 3m water depth from sea will be stored in a RCC feed tank. The Seawater stored in feed tank will be tested for the micro organism content and will be pumped to the control tank without ballast water treatment, and will be stored in control tank for 5 days. Parallel to this, processed seawater stored in feed tank after checking for the micro organism content will be pumped to test tank through the “Ballast treatment equipment” and

stored for 5 days. Sampling & testing of seawater will be carried out from this tank. After testing and sampling is completed the tested water stored in control and Test tank will be directly pumped (dewatered) through outfall pipe to 2.5m water depth at sea after necessary treatment. The above described test will be repeated for 4 more cycles.



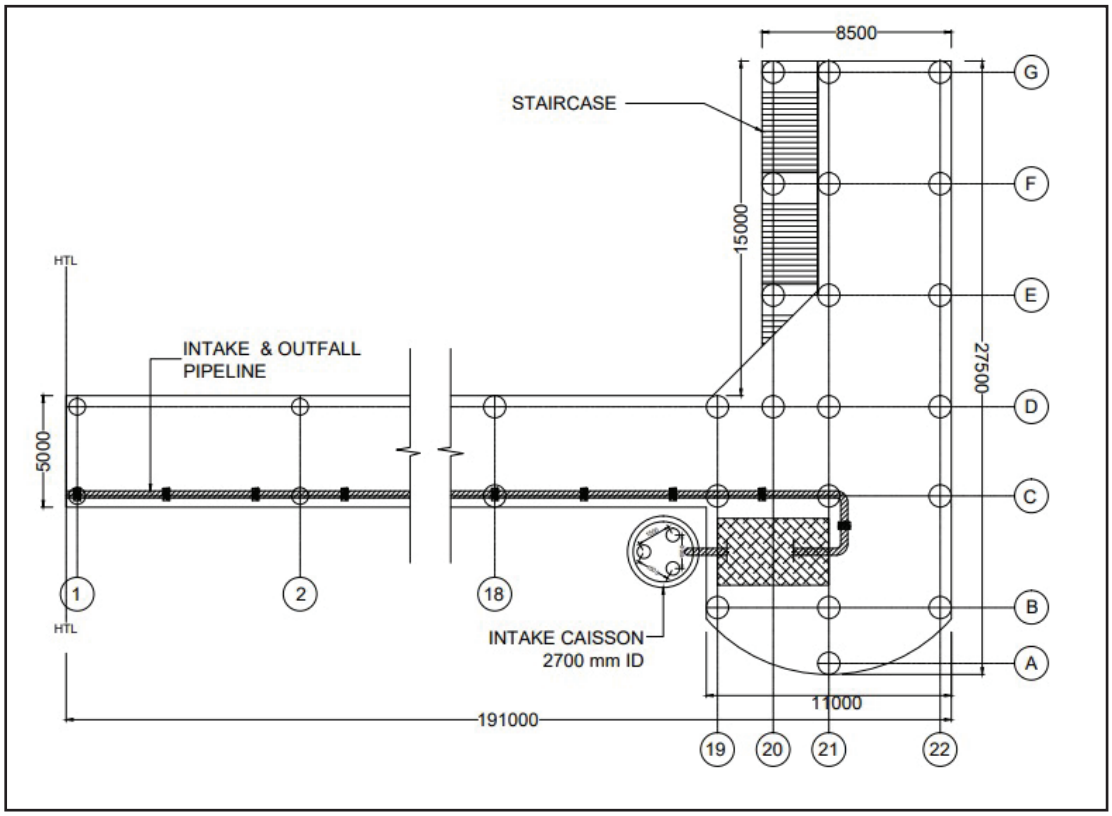
Ballast Water Treatment Technologies – Test facility (BWTT-TF)

(ii) Approach trestle

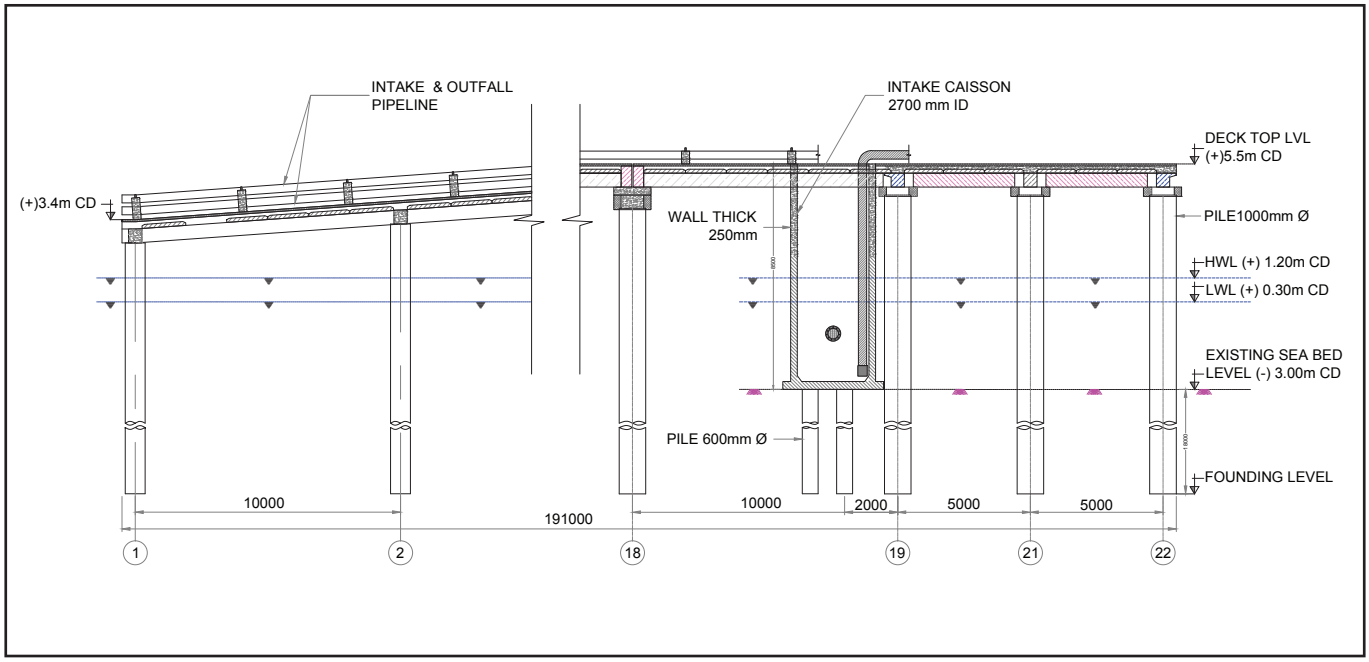
The Trestle connects the caisson and test facility on shore. The purpose of the trestle is to:

- Support the pipelines which carry seawater from the caisson to the plant, and
- Provide access for the installation, operation and maintenance of the Ballast pumps near the caisson.

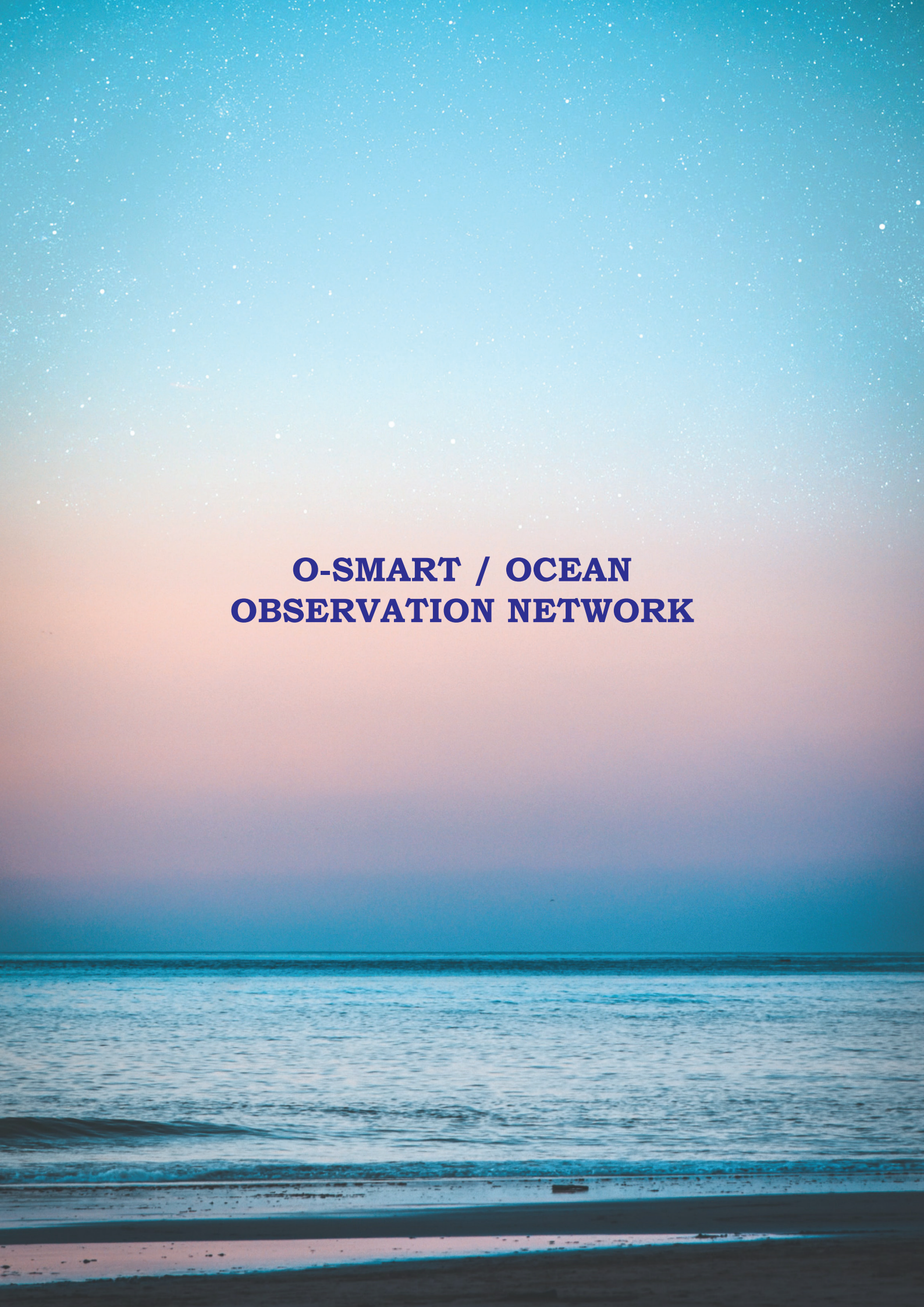
The depth of piles supporting the trestle varies with sea bed profile. The length of the trestle is arrived at, based on the location of caisson. The maximum embedded depth of the piles from sea bed is 18.0m.



Conceptual layout of Pipeline trestle



Longitudinal section of Pipeline trestle



O-SMART / OCEAN OBSERVATION NETWORK

5. O-SMART / OCEAN OBSERVATION NETWORK

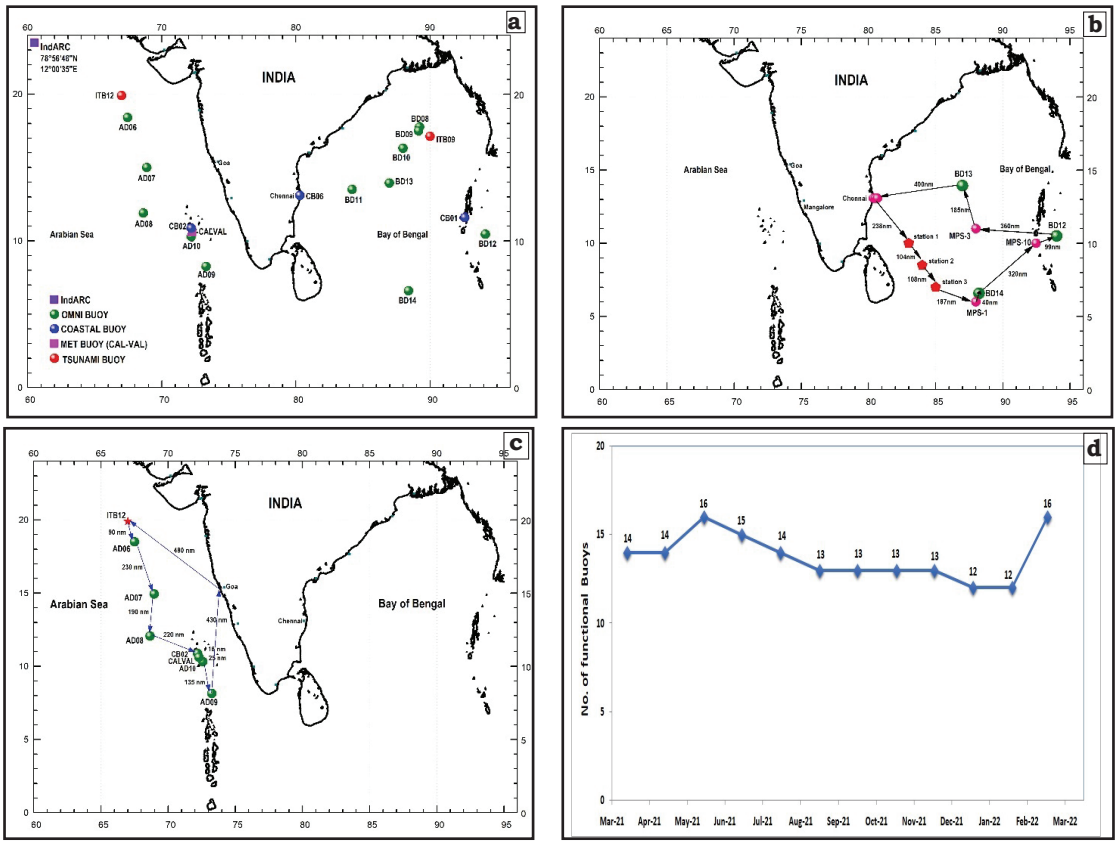
5.1 OCEAN OBSERVATION SYSTEMS

The mandate of the group is

- To maintain Moored Ocean Observation Network comprising of Met-Ocean, CAL-VAL and Tsunami buoy systems for data collection and to disseminate data to INCOIS and to support RAMA buoy network under the INDO-US collaboration.
- To provide with Ocean observational tools, prototype and technology development.
- To conduct collaborative R&D projects, capacity building with National and International Institutes / Organizations.

Background

Under the Ocean Observation Network (OON) programme of ESSO MoES, the Ocean observation systems (OOS) group of NIOT is entrusted with undertaking the activities on moored buoy programme. The OOS group, erstwhile National Data Buoy Programme, was established in 1997, with the objective to operate, maintain and develop moored observational buoy networks including data buoys & Tsunami buoys and related telecommunication facilities in the Indian seas. The real time data collected from these buoys are disseminated to INCOIS, Hyderabad.



(a) Moored Buoy Network in the Northern Indian Ocean, (b) and (c) Cruise track for servicing/deploying buoys in the Bay of Bengal, and Arabian Sea & (d) Functional buoy status from Apr 2021 to Mar 2022

The OOS programme also contributes to the implementation of Research moored Array for African-Asian-Australian Monsoon Analysis and prediction (RAMA) buoys by NOAA in the Indian Ocean region. In addition, OOS has established and maintained the CALVAL buoy system for satellite data validation in collaboration with SAC ISRO and the IndARC (Arctic mooring system) jointly with NCPOR, Goa.

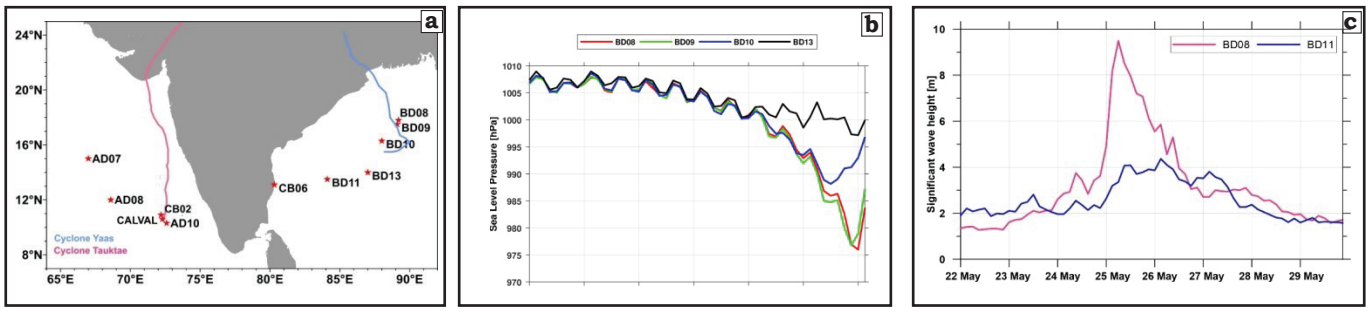
During this period, OOS has undertaken 6 cruises / field trips, 77 days of sailing covering a distance of approximately 7185 nautical miles for completing 26 operations (13 deployments & 13 retrievals) in the Bay of Bengal and the Arabian Sea.

In addition, OOS is also supporting the satellite-based programs of ISRO, India, for its validation (CAL-VAL) of satellite data with in-situ buoy data off Kavaratti Island. OceanSITES buoy data is successfully shared with OceanOPS in BUFR format and Indian Tsunami buoy system alarm mode data shared and displayed in NDBC website. Metadata is prepared and updated till date for Deep ocean and coastal NIOT buoy systems.

OOS has been systematically carrying out preparations for executing these tasks in spite of several challenges faced such as ship time availability, adverse weather conditions, inaccessibility to the site in case of any eventualities, vandalism, a lengthy procurement process and large inventory. OOS group of NIOT continued to operate its 24 x 7 data reception centre CORNEA, amidst pandemic lockdown. OOS team for direct support, remote support and emergency support were identified and tasks were allocated for continuous operation. In addition, efforts have been put forth to monitor and track buoys by continuously coordinating through Ports, NHO, Indian Navy, Indian Coast Guard and confirmation on sighting of buoys at high sea were received from these respective agencies after carrying out visual inspection by deploying Naval and CG Vessels and Air craft for field and aerial surveys.

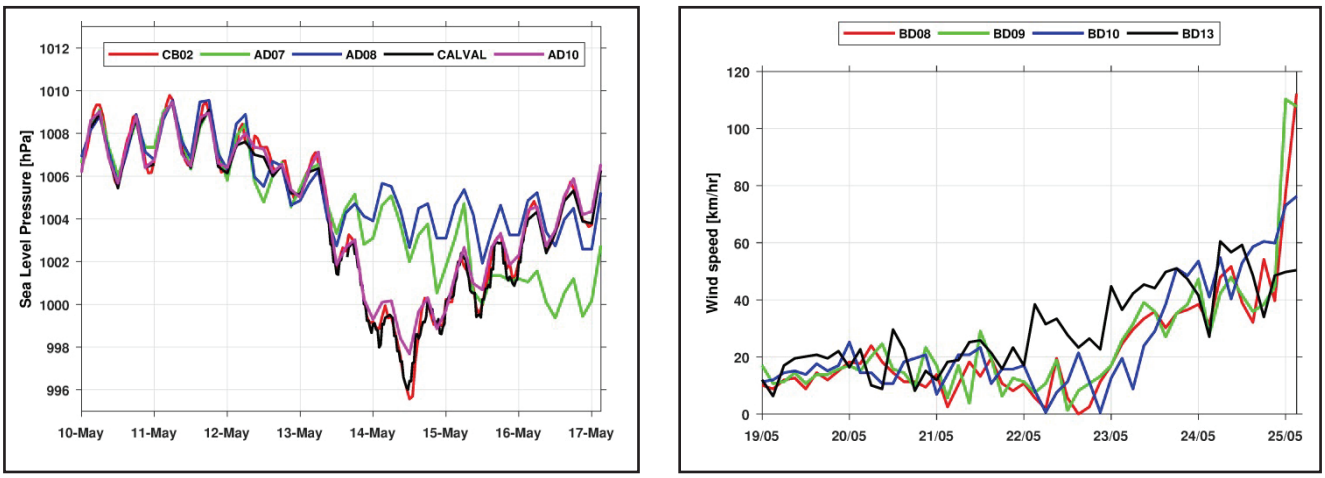
Data Buoy Observations during Cyclones

The moored buoys deployed by the OOS captured the signals of two cyclones namely severe cyclone Yaas in the Bay of Bengal and extremely severe cyclone Tauktae in the Arabian Sea. Four OMNI buoys namely BD08, BD09, BD10 and BD13 recorded significant drop in sea level pressure (SLP) during the Yaas cyclone in May 2021. Minimum SLP was observed in BD08 and BD09 (976 hPa) with a corresponding wind speed of 112 km/hr. Significant wave height of 9.49 m and maximum wave height of 12.83 m indicates the severity of the sea state during the cyclone passage.



(a)Track of cyclones Yaas, Tauktae and moored buoys, (b) Sea Level Pressure and (c) Significant wave height during Yaas cyclone

The signals of Extremely Severe Cyclone Tauktae in the Arabian Sea was captured by four buoys, CalVal [72.29E/10.60N], CB02 [72.20E/10.87N], AD07[69.5E/15N] and AD10 [72.50E/10.30N], which recorded SLP drop of ~ 8-10 hPa. The minimum SLP of 996 hPa was observed in the CalVal buoy and recorded maximum wind speed of 70 km/hr. Significant wave height of 3.2 m and maximum wave height of 5.13 m have been recorded in the buoy situated at a distance of 489 km from the track. The buoy observations revealed that the pre-cyclonic Sea Surface Temperature [SST] in the Arabian Sea was more than 30.5 °C with the Tropical Cyclone Heat Potent potential of ~110-120 kJ/cm^2 that provided favourable environment for the intensification of the cyclonic storm.



(a) Sea Level Pressure during Tauktae cyclone in Arabian sea and (b) Wind speed at 10 m height during Yaas cyclone in Bay of Bengal

Technology Developments

Apart from undertaking year-round regular maintenance activities of moored buoy systems in both Bay of Bengal (BoB) and Arabian Sea (AS), OOS continuously strives to enhance the systems to a satisfactory level through indigenization efforts.

(i) Development and Installation of Indigenous Autonomous Rain Gauge (IARG)

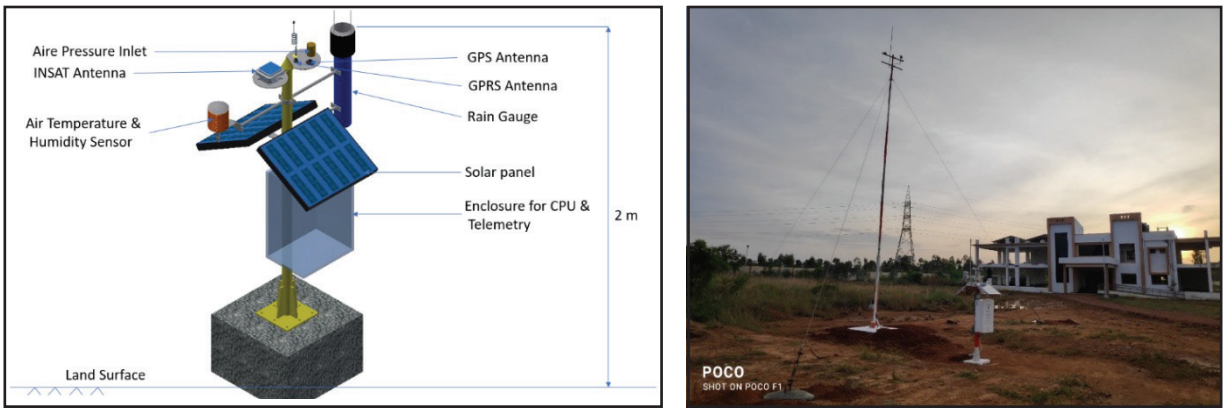
OOS has successfully developed an Indigenous rain gauge working on capacitive principle for the measurement of rain in weather stations, moored buoy systems and also in the Automatic Rain Gauges. For floating platforms such as moored buoy systems, the capacitive based precipitation measurement with catchment funnel and measurement tube is suitable considering the floating and unstable nature of the platform. The indigenously developed rain gauge is designed with a capacitive transducer which senses the water column height and a self-contained electronic circuit converts the capacitance value to a calibrated voltage output which is proportional to precipitation. The gauge has the automatic self-siphon facility for automatically draining the measuring chamber once the measuring chamber is filled by the accumulated rainfall. Periodic interrogation by a data logging system (sampling at 1Hz with interval of 2 minute) allows computation of the total precipitation and rate. Features like use of bird spike in the catchment area to avoid birds sitting on the sensor and installation of plastic guard inside the funnel filters the entry of foreign objects into the gauge and also ensures quality data & long term performance.

IRG installed at NIOT and IRG sensor.

NIOT has successfully installed an IARG which collects the time-series data from Rain gauge (precipitation sensor), Air humidity and temperature sensor at synoptic hours and transmits the information in GTS format in real-time through INSAT/GPRS and is shared with Indian Meteorological Department (IMD).

(ii) Installation of AWS at NIOT-Nellore campus

An automatic weather system (AWS) with indigenous data acquisition system (DAS) was installed at NIOT campus at Chittedu, Nellore on 11th August 2021. The system consists of an Indigenous CPU, Wind sensor mounted in a 10 m high tiltable mast, Humidity & Air temperature sensor, Air pressure sensor and Precipitation sensor. The transmission of real-time data from Nellore to NIOT is using GPRS & INSAT and the received data is shared with IMD.



AWS installed at Nellore NIOT campus

(iii) Implementation of IRIDIUM telemetry in Data/Tsunami buoy systems

Work on installation of Iridium modems with buoy systems is being undertaken during this reporting period. INMARSAT satellite services are used by NIOT since 1997 for transmission of data from buoy systems. INMARSAT telecommunication uses two-way for data transmission and the services are offered by geostationary satellites (at 36000km altitude) and the power requirement of transceiver is approximately 30W, this requires high capacity battery packs in buoy system and the data latency is more (5 to 12 minutes). The usage of IRIDIUM telemetry will

result in drastic reduction of telemetry power requirement (less than 5W) as it uses Low Earth Orbiting (LEO) Satellite (at 780km altitude). Also the data latency will be reduced to less than a minute which helps in faster transmission of data to the reception centre. The data rate of IRIDIUM telemetry is 2400bps whereas for INMARSAT the data rate is only 600bps. Considering above, necessary approvals are already received from Department of telecommunication (DOT) and Ministry of Home Affairs (MHA) for using iridium modem with buoy systems. Works have been initiated to interface the Iridium terminals with the existing data and tsunami buoy systems subsequently after the receipt of terminals.

(iv) Deep Sea Camera System

Deep sea camera system was developed for long term oceanographic application. The custom made voltage regulator and timer circuit was implemented using a PIC microcontroller. The timer board wakes the camera module at an hourly interval and records the video footage for 5 mins before entering into the idle state to conserve the battery. This system was successfully retrieved on 29th June 2021 and an interesting footage of acoustic release ascending towards the sea surface was recorded. The system also recorded the acosticpinger sound from the acoustic release and footage of a school of fishes and turtle near the surface. An Indian Patent has been filed for this product.

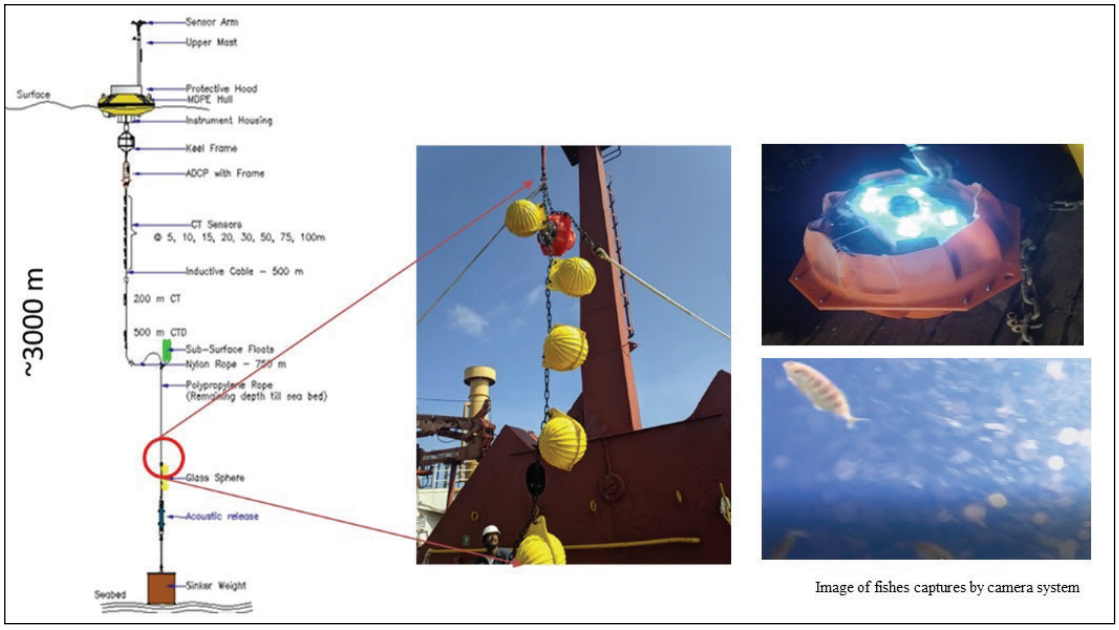


Image of fishes captures by camera system

The deep sea camera system integrated with mooring and snapshot from a footage captured.

(v) Fishing vessel based Oceanographic observation system

The oceanographic measurements close to the coastal region is limited due to the presence of fishing vessel and the remotely sensed coastal oceanographic parameters are also biased due to various factors. In order to increase the measurement close to the coastal regions, the idea of using fishing vessel is envisaged and a prototype was demonstrated to collect real time data from the fishing vessel.

(vi) Artificial Intelligence based data acquisition system

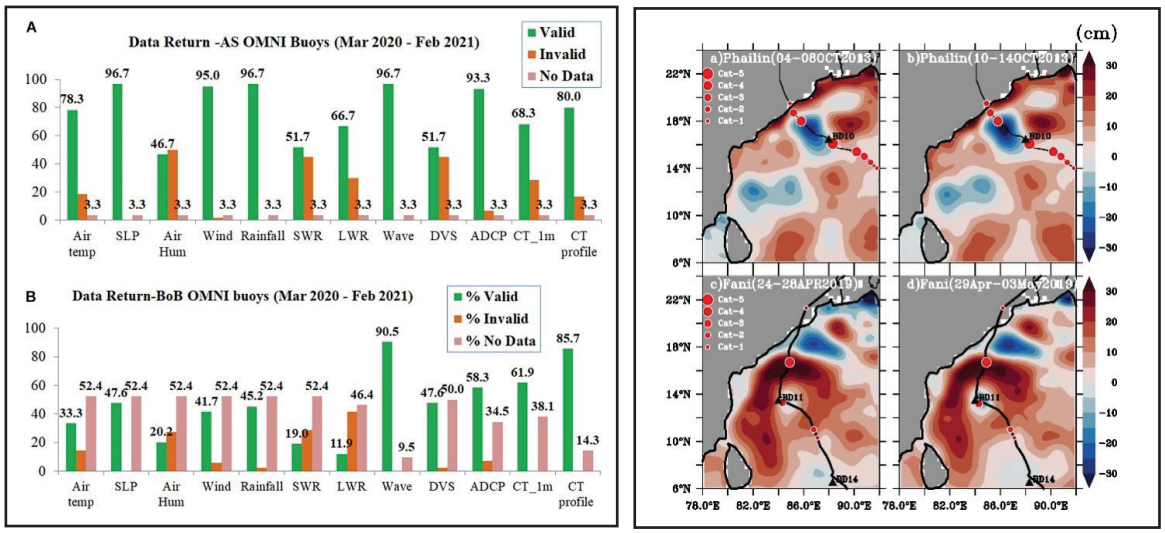
An Indian patent is filed for the invention titled "Artificial intelligence based autonomous data acquisition system and method for deep ocean and subsea environments" was filed. The system comprises a monitoring device which further comprises a sensor module, an analysis module, a central controller module, a vertical movement control module, a power control module, and a telemetry module. The artificial intelligence based autonomous data acquisition system aids in autonomous long term data collection at deep sea and subsea levels.

Buoy Data Analysis and Results

Moored buoy observations are utilised to identify the upper ocean dynamics and its variability in AS and BoB. The significant results are published in peer reviewed journals and the gist is presented in the following sections.

(i) Sustenance of moored buoy network during Covid Lockdown

The improvements in the buoy system, in-house developed data acquisition system, and efforts made in ensuring the quality of measurements together with "best practice methods" enabled 73% of the buoy network to be functional even when the cruises were reduced to 33% during the COVID-19 lockdown in 2020. The moored buoys equipped with Indian buoy data acquisition system triggered high-frequency transmission during the Super cyclone Amphan in May 2020, the cyclone early warning services greatly helped during the COVID-19 pandemic and was well appreciated by the user community.



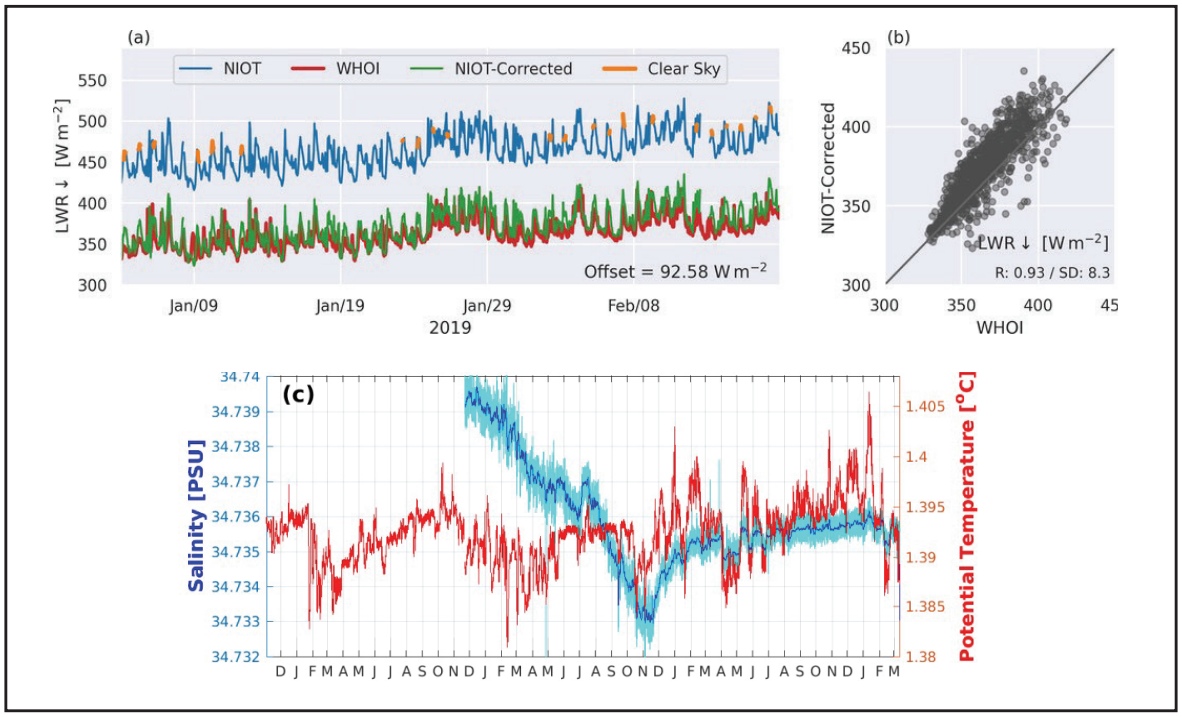
The data return from OMNI buoys during the COVID pandemic in 2020 and the modulation of the intensities of the cyclones Phailin and Fani over the mesoscale eddies.

(ii) Tropical cyclone intensity modulated by the oceanic eddies in the Bay of Bengal

The study on the intensity modulation of two intense cyclones Phailin and Fani in the Bay of Bengal by the mesoscale eddies revealed that mesoscale eddies can modulate LHF by 20 W m^{-2} over eddies during cyclone passage emphasising the need for air-sea interaction associated with eddies for improving cyclone intensity forecasts.

(iii) Long wave radiation corrections in OMNI buoys

The LWR↓ offset induced by the problems in thermopile amplifier were identified through comparison with a standard reference system. A reliable method to correct this offset in LWR↓ is developed and revamping of radiation measurements which was carried out for 12 NIOT-OMNI buoys over 8 years to improve the estimation of air–sea fluxes in the Indian Ocean.



(a & b) Offset correction in Longwave meaurements and (c) the the salinity and temperature variability near sea floor in Arabian Sea.

(iv) Is the deep-sea ecosystem insulated from surface ocean physical variability?

The abyssal ocean is supposedly a seasonal environment. Four yearlong (Nov 2018-Mar 2022) near-seafloor moored time-series observations of temperature and salinity in the Arabian Sea at a depth of 4000 m revealed clear seasonal signatures characterized by a warming pattern peaking during winter. The seasonal near-seabed temperature variability is influenced by bottom water mass circulation variability, Rossby waves, and deep meridional overturning circulation.

(v) Characterizing near-surface salinity variability in the northern Bay of Bengal and its potential drivers during extreme freshening years of the 2011-2019 period

The near-surface salinity (within 10 m from sea surface) variability is analyzed using observations from a moored buoy supplemented with satellite observations. The analysis revealed prominent interannual variability in the time of occurrence and persistence. Considerable variability in offshore advection of low salinity water during 2011, 2015 and 2017 is mostly due to the variability in the wind-driven surface current and the location of mesoscale eddies.

(vi) Wave energy estimation using OMNI measurements

The site specific, monsoon driven, sea-state dependent, swell dominant wind-wave relationship has been formulated considering the inter-annual variability of OMNI buoy wind and wave measurements (2013-17). ERA5 model based, site specific wave energy period ratios for the swell dominant wave field deduced from 10 years (2011-21) of OMNI buoy measurements exhibit significant seasonal variability.

(vii) Studies on Wave Induced Stokes Drift using NIOT Moored Buoy Measurements

Wave induced Surface Stokes Drift (SSD) is significant during cyclones. Works carried out to identify the best set of wave statistical parameters to represent the rapidly varying sea, swells compositions based on the track distance during cyclones and is equivalent to the spectral SSD of ERA5.

5.2 HF RADAR

The 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, laboratory studies, innovative materials, numerical modelling studies and comprehensive detailed engineering designs.

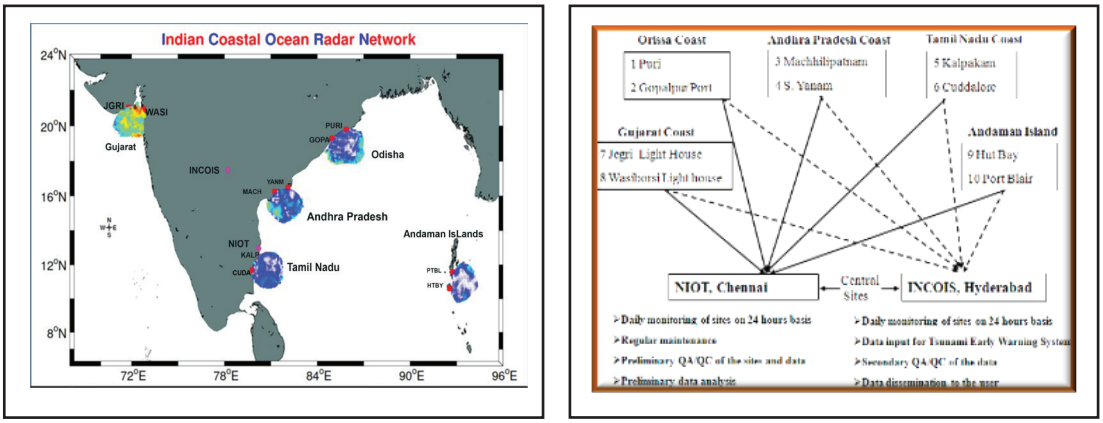
Background

The group is currently involved in various research activities for development of sustainable coastal protection measures, shoreline management along open coasts and coastal inlets, evaluation of shoreline response to human interventions and climate change, coastal observations, developing design criteria for coastal infrastructure and marine ecology. High Frequency (HF) Radar is a tool for synoptic on-line mapping of surface current fields and the spatial distribution of the wave directional spectrum. These instruments map surface currents in wide swaths of coastal waters up to 200 km off shore, 24 hours a day, and in all weather conditions. The Unique Nature of HF Radar High- frequency (HF) radio formally spans the band 3-30 MHz (with wavelengths between 10 meters at the upper end and 100 meters at the lower end). For our radars, we extend the upper limit to 25 MHz.

- Operation and maintenance of HF Radar remote sites along Indian coast.

Indian Coastal Ocean Radar Network

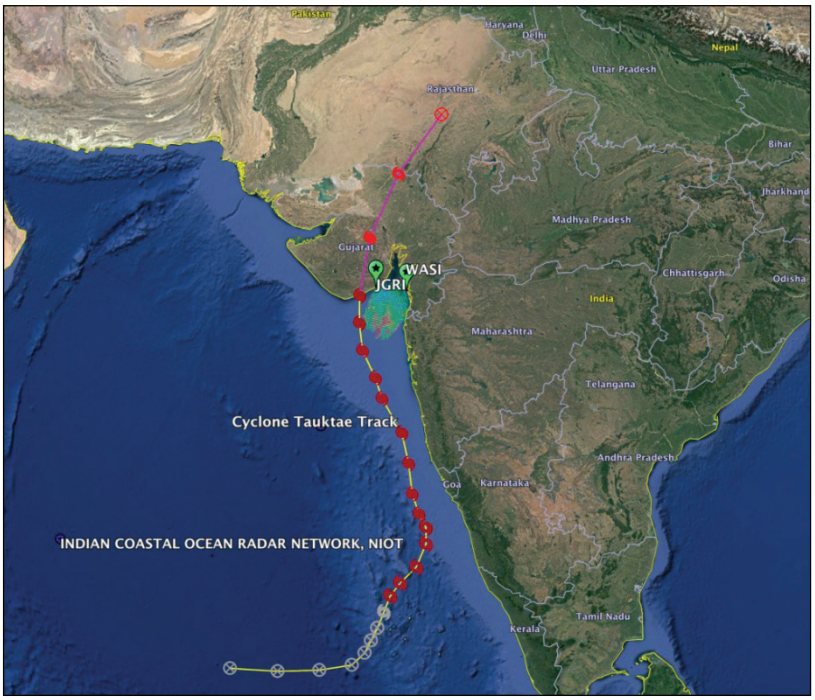
The Indian Coastal Ocean Radar Network (ICORN) is operated and maintained by CEE division of NIOT. ICORN runs 10 HF Radar systems along the Indian coast. This project is under Ocean Observation Network (OON) Program of MoES. The data from 10 remote sites are transferred simultaneously to central servers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



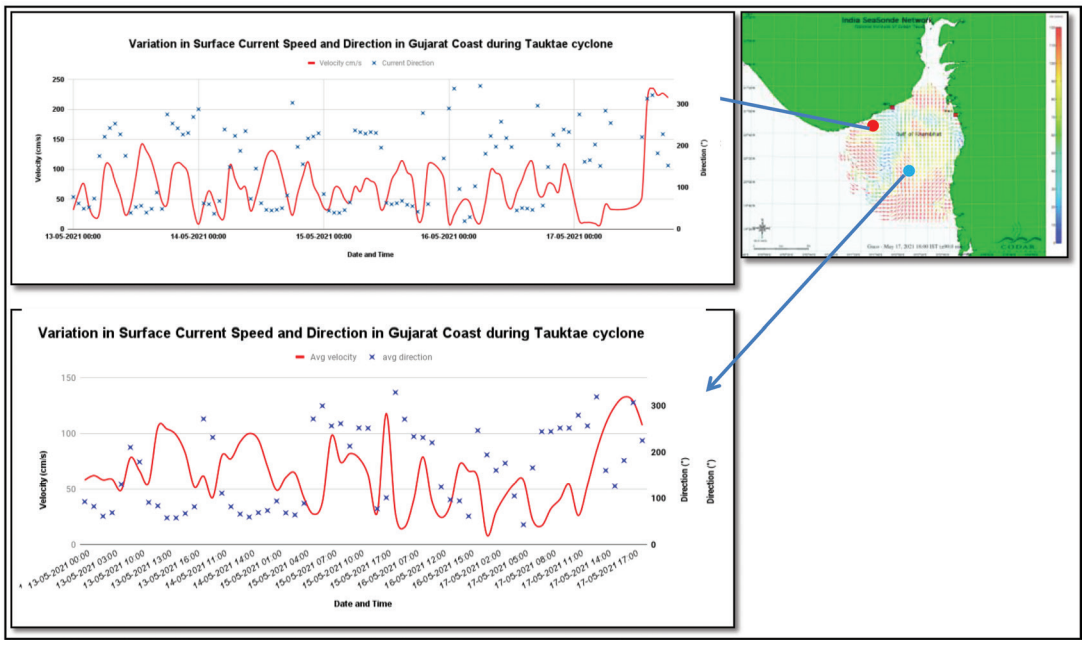
HF Radar locations

- Indian Coastal Ocean Radar Network (ICORN) is operated and maintained by NIOT, which runs ten HF Radar systems along the Indian coast. Nine sites are working fine along Indian coastline and Andaman & Nicobar Island. Group has taken precautionary actions during COVID-19 to continue the operation at all the ten sites. The AMC of allied services for all HF Radar remote sites has been established successfully.

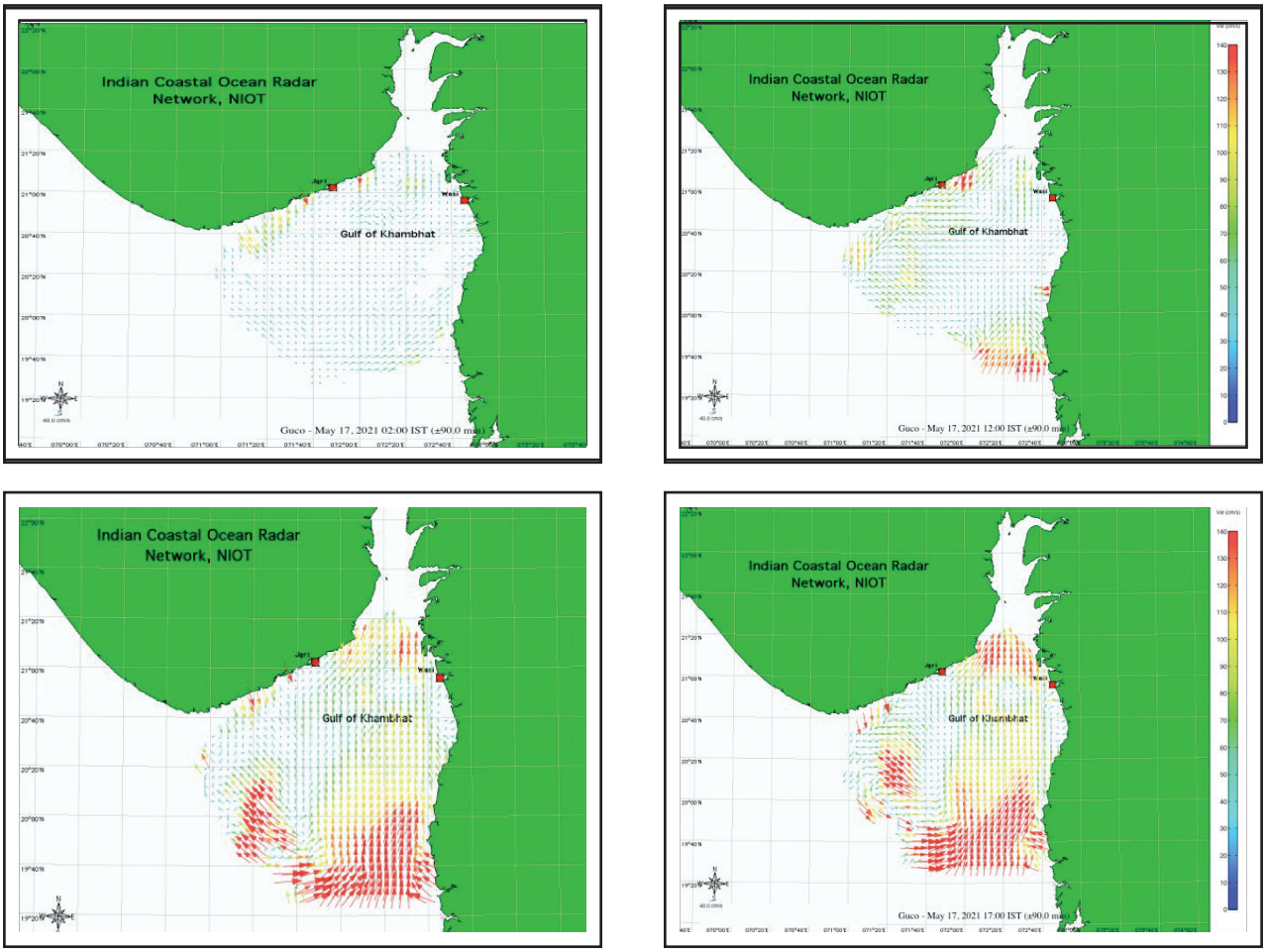
- Cyclone Tauktae originated from a tropical disturbance that drifted eastward and organized into a deep depression by May 14. High-Frequency Radar (HFR) operated by the National Institute of Ocean Technology (NIOT) at Jegri & Wasi Borsi had tracked the surface currents and high wave activity within its measuring limits. The radar data provides valuable information on the surface dynamics during the cyclone period. The HF radar remote site data reception status for year 2021 is presented here.



Cyclone Tauktae track and ICORN site installed along the west coast
(green star mark indicates the HF radar installations)



Time series of surface current measurement during Tauktae cyclone



Surface current during Severe Cyclone Tauktae

HF Radar Data Reception										
SITE (INSTALL DATE)	CUDA (MAR 2008)	KALP (MAR 2008)	MACH (MAR 2008)	YANM (MAR 2008)	WASI (Feb 2009)	JGRI (Feb 2009)	GOPA (Nov 2009)	PURI (Nov 2009)	PTBL (MAY 2010)	HTBY (MAY 2010)
Year 2008	43 (Mar-Jun)	89 (Mar-Sep)	85 (Mar-Apr)	29 (Mar-Apr)	Sites are Not installed				Sites are Not installed	
Year 2009	82	91	59	10	39	62	86	90		
Year 2010	61	100	82	45	73	89	45	73	70	85
Year 2011	88	99	90	63	75	87	76	86	74	89
Year 2012	33	96	67	63	80	79	52	54	53	76
Year 2013	54	55	69	29	91	41	50	30	62	47
Year 2014	96	97	85	81	71	83	2	73	66	93
Year 2015	94	96	66	78	36	82	96	96	97	51
Year 2016	73	91	74	53	56	76	58	72	70	74
Year 2017	84	92	78	60	60	72	65	77	77	77
Year 2018	95	97	94	86	96	89	89	96	97	92
Year 2019	87	86	96	79	97	90	83	34	99	92
Year 2020	99	99	57	80	94	91	76	5	100	91
Year 2021	89	98	78	69	99	74	76	97	94	77

	>=70%
	>=50<70%
	<50%
	Sites that are not Not installed

HF Radar remote sites data reception status

O-SMART / OPERATION AND MAINTENANCE OF RESEARCH VESSELS

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

6.1 VESSEL MANAGEMENT CELL

Vessel Management Cell [VMC] team of NIOT is responsible for operations, maintenance & technical management of research ships and scientific equipments onboard. VMC ensures successful implementation of Ocean related programmes by providing a Technically Suitable Platform for various research institutes under MoES in conjunction with the Joint Scientific and Technical Advisory Committee [JSTAC] approved cruise schedule. Currently there are four vessels under NIOT viz., ORV Sagar Nidhi, ORV Sagar Manjusha, CRV Sagar Tara & CRV Sagar Anveshika. These vessels operate year-round, supporting the Ministry of Earth Sciences, Govt. of India funded projects.

VMC consists of a team of Engineers who support the research ships on a day to day basis, to ensure that the vessels continue in the delivery of data and are where they are supposed to be at a given date. They also collect scientific data and compile the data collected during the expedition.

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 systems and has enhanced the operational time by minimizing down time hence benefitting the scientific community to a great extent.

Background

NIOT/MoES has a fleet of Research Vessels for ocean exploration & for technology demonstration. Research Ships managed by NIOT are versatile ocean observing platforms equipped with advanced scientific equipments and mechanical handling equipments for technology demonstration and oceanic observations, which are on par with International Standards. Research ships play a vital role in scientific studies relating to ocean /atmosphere/ technology etc. It is important to suitably prepare ships for numerous scientific activities keeping safety as utmost priority.

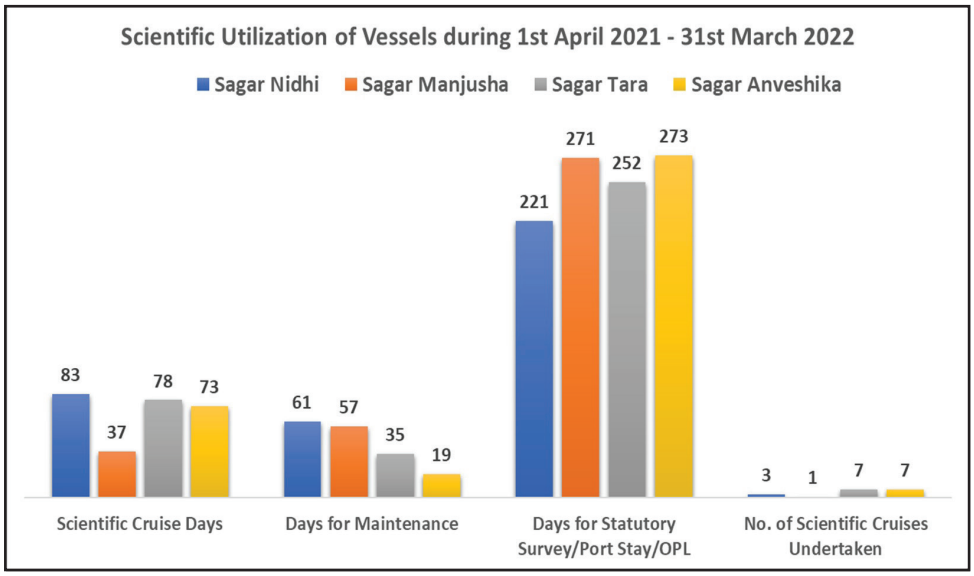
Decommissioning of Sagar Purvi

Coastal Research Vessel Sagar Purvi was officially discontinued from her services to the research community & was disposed-off on 2nd June 2021 through MSTC. Sagar Purvi has completed more than 470 scientific cruises spending approximately 4200 days at sea for scientific operations since 1996. A Voluminous data has been collected during various coastal studies, geological studies, marine biological studies, atmospheric studies & ocean observations. A news article on the “NIOT vessel Sagar Purvi decommissioned after 25 years” was published in various National Newspapers.

Scientific Utilization of Vessels during 1st April, 2021 to 31st March, 2022
[No. of Days - 365]

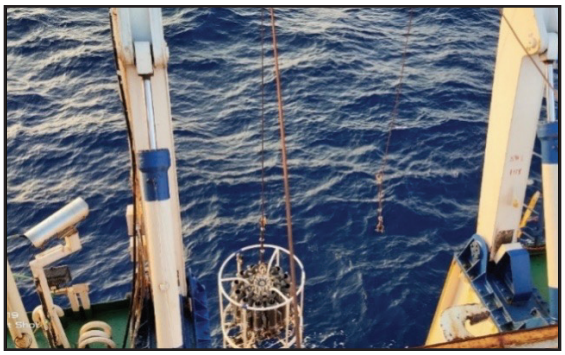
Ship	Scientific Cruise Days	Days for Maintenance	Days for Statutory Survey/ Port Stay/OPL	No. of Scientific Cruises Undertaken
Sagar Nidhi	83	61 [Dry-dock and Afloat Repairs]	221 [Statutory survey, Bad Weather, Waiting for Dry-dock, OPL as per directives of MoES]	3
Sagar Manjusha	37	57 [Dry-dock and Afloat Repairs]	271 [Statutory survey, Bad Weather, Waiting for Dry-dock, OPL as per directives of MoES]	1
Sagar Tara	78	35 [Emergency Dry-dock, AHU, BT, Gyro Servicing]	252 [Statutory survey, Bad Weather, Lay-Up as per DG Shipping Guideline, OPL/ Port Stay as per directives of MoES]	7
Sagar Anveshika	73	19 [Auxiliary Engine PMG Coil Renewal]	273 [Statutory survey, Bad Weather, OPL/Port Stay as per directives of MoES]	7

*All Research vessels under NIOT have been strictly adhering requisite precautions w.r.to COVID-19 & All routine maintenance w.r.to Scientific Equipment, Shipboard machinery and Material handling equipment are being carried out at Anchorage/Port. #Ships stay at Anchorage/ Port as per directive from MoES on revised prioritized cruise plans as per the Committee's report.



Major cruises/significant work undertaken onboard NIOT Fleet

- INCOIS for SAIC buoy & glider deployment in Bay of Bengal and Indian Ocean onboard Sagar Nidhi,
- DST-NIOT for Successful completion of Deep Sea Mining Crawler trials at CIOB upto 5270 m,
- DST-NIOT for Manned Submersible-Sphere trials at Bay of Bengal,
- OE-NIOT/INCOIS for AUPD and Wave rider Buoy deployment at Bay of Bengal onboard Sagar Tara,
- Collection of water and sediment samples for the analysis of different bio-geochemical parameters and microplastic Study by NCCR Cruise in Bay of Bengal onboard Sagar Tara and
- DST for MBES Survey and Sampling in Bay of Bengal onboard Sagar Anveshika.

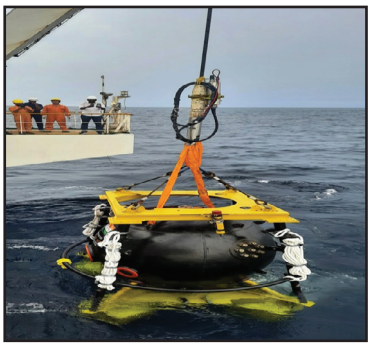


CTD Deployment upto 1000m depth

Deployment of Glider

V1 mining machine deployment

Sea bed images at 5270 m depth



Deployment & Retrieval of Sphere in Bay of Bengal at 617m and 500m Depths

INCOIS/OE-NIOT -Wave rider buoy deployment off Chennai

NCCR: Coastal buoy deployment off Chennai

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

- Sagar Nidhi & Sagar Manjusha is undergoing mandatory dry-dock & afloat repairs at CSL, Cochin.
- Both the Ships were successfully undocked on 23rd April 2022 after completion of all underwater work as per the defect list/approved AWRFs/15 yearly class survey work & class recommendations.
- Afloat repairs are under progress. Scheduled work as per the dry-dock scope & work plan is progressing satisfactorily.
- VMC team along with the overseeing surveyor are closely monitoring the progress of the dry-docking work from NIOT's perspective & to ensure mandatory surveys as per statutory guidelines.
- Regular inspections & progress review meetings are held with the TFEC/VMC Team to ensure timely completion of work.

Sagar Manjusha Dry-docked at CSL

Sagar Nidhi Dry-docked at CSL

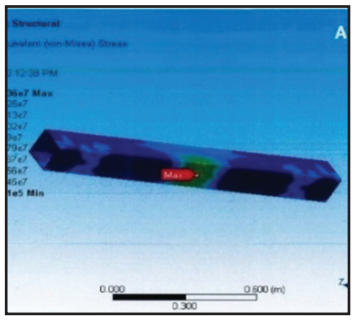
Major technical contribution

Design, Fabrication & Installation of CTD Winch base frame onboard Sagar Manjusha

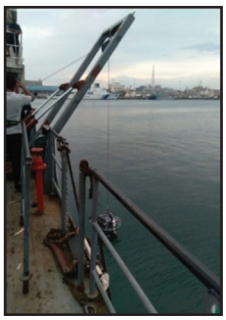
The new CTD winch base frame along with A-Frame and hydraulic component were designed by VMC, NIOT team. Finite Element Analysis for base frame of CTD A-Frame was performed to ensure the load bearing capacity and to choose the suitable grade of materials. The critical points like deck strengthening, point load of the winch and positioning of girders and carlings were identified and addressed in a professional manner which was also approved by IRS Classification Society. Efforts are appreciated by JSTAC.

Fabrication of Base frame and installation of New CTD winch

CTD winch A-Frame installation



FE Analysis in Ansys software for the frames and foundation



CTD Deployment and winch Testing

Development of Marine Engineering Standards

VMC team have prepared draft Standards to the Bureau of Indian Standards [BIS] in standardization processes & contributed towards developing Indian Standards w.r.to Shipbuilding, Marine Engineering & Safety Aids aspects, which were well appreciated by the Bureau of Indian Standards [BIS] & DG Shipping.

Viability Analysis on Interoperability of Hybrid Battery solution for a Research Ship

Electrical propulsion with battery back-up is one model gaining traction. The option to harvest power and store in batteries, which can be used when in need would mean good economics. The power requirements and the harvesting range are optimized thus paving the way for settling on the architecture for a research vessel.

Capability Plot Study of Vessels for Dynamic Positioning Arrangements

Vessels without DP arrangements are potential candidates for retrofits, which would augment their capabilities and count as back-up. A study of capability checks for such vessels was undertaken. Rather than scrapping the old vessels and buying new with DP facilities, this option would be economical.

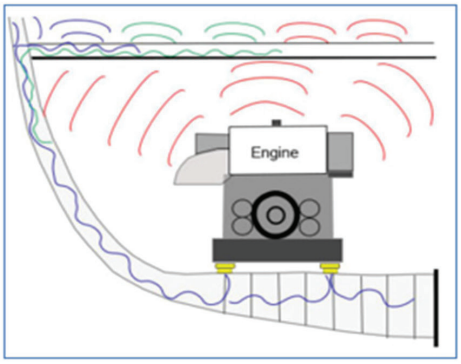
Various alternative technologies w.r.to abatement of Shipborne emissions was analysed.

Some of the engineering solutions developed by VMC are already adopted as technical procedures of the statutory body-IRS and efforts are underway towards patenting the same jointly by NIOT/ IRS.

Design & Development of basic architecture of a knowledge-based engineering (KBE) assistance system

As per IMO regulations and as part of the implementation of Integrated Vehicle Health Management [IVHM] for NIOT Research Ships to identify components of Ship's machinery which are critical in respect to noise/vibration creation, transmission or radiation for further development of noise & vibration reduced systems in Research Ships is under progress. Measurement, analysis and evaluation of onboard ship noise and vibration level are carried out for the comfort of scientists as per the requirements of IMO resolutions & ISO standards in addition to class requirements.

Due to the implementation of IVHM, all the handling equipments were maintained well and could achieve the planned targets successfully, which was well appreciated by Users/JSTAC.



Ship Speed [Sagar Nidhi]	Keel aspect wide band source level
Knots	dB re: 1 µPa at 1m
6	158
8	162
10	168

Critical Ship's machinery generating noise / vibration

Digital Poompuhar: Underwater data acquisition

As a part of the Digital Poompuhar project, VMC-NIOT has accomplished 75% of the project objectives with respect to multi beam echo sounder (MBES) survey, generation of bathymetry chart, generation of digital terrain model and identification of probably scattered remains/ objects/features related to submerged Poompuhar.

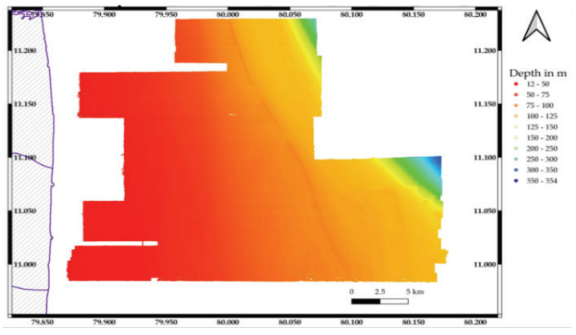


Figure : MBES bathymetry processed output of Poompuhar study site. The data has been collected for four different blocks at different water depths. The colour dots in the legends represents the depth details of the study site.

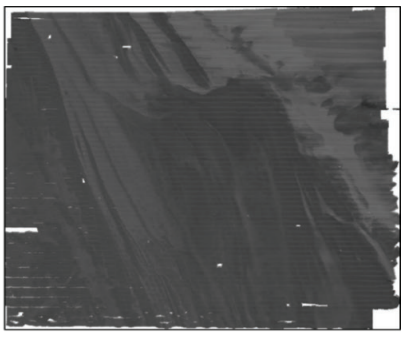
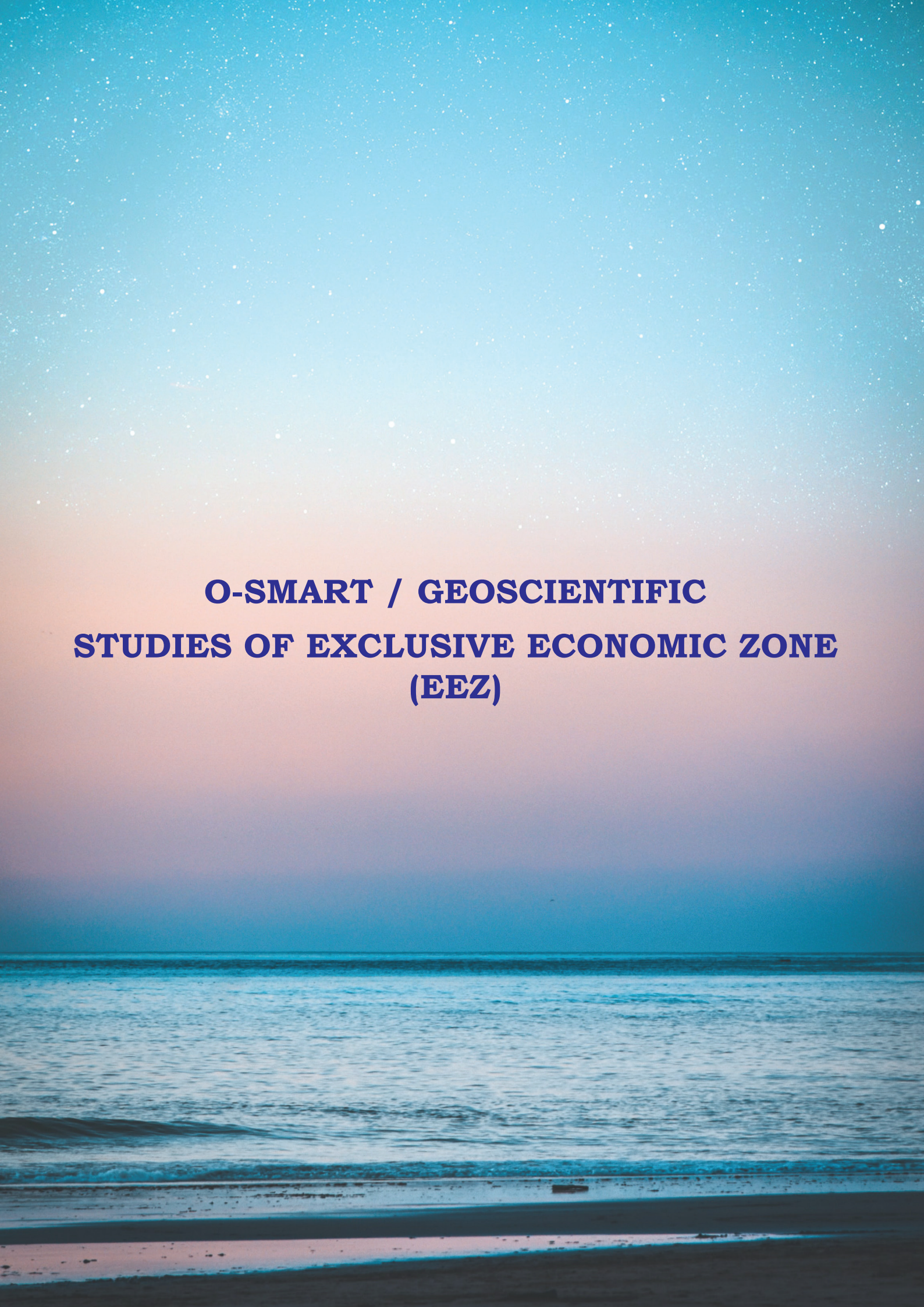


Figure : MBES backscattered processed output of a selected block. The figure represents sedimentological characterisation of the study site. The deep colour indicates the availability of coarse sand and the lighter shade indicates the availability of finer particles.

Based on the preliminary interpretation using the MBES data output, sub-bottom profile data has been collected and the same has processed for further identification of sub sea bed features. The ground truth sediment samples also collected and analysed using onboard texture analyser were validated with MBES backscattered data.



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

The 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.

Background

The group is currently involved in various research activities for development of sustainable coastal protection measures, shoreline management along open coasts and coastal inlets, evaluation of shoreline response to human interventions and climate change, coastal observations, mapping of seabed, developing design criteria for coastal infrastructure and marine ecology.

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

The Ministry of Earth Sciences (MoES) is implementing number of programs through its constituent centers where numerical simulation studies are a major component. The bathymetry data is a primary source of data for any basic oceanographic study. The shallow water bathymetry shall improve our understanding of the seabed morphology. At present, scientific groups and modelers are depending on hydrographic charts and international public domain data set for shallow water and deep-water bathymetry. The shallow water bathymetry dataset along Indian Ocean shall provide better understanding of seabed, coastal process and numerical model studies.

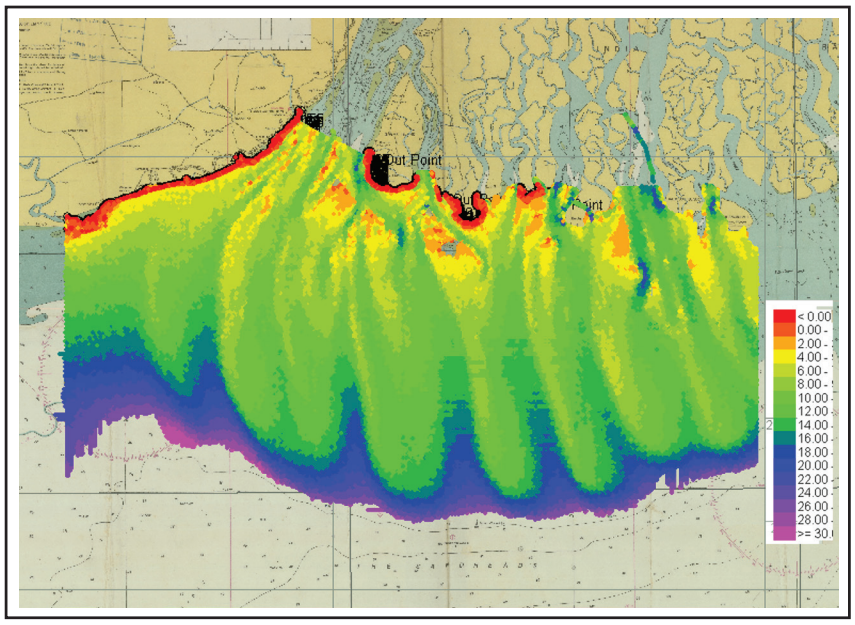
Group has started the survey work at Tamil Nadu using existing infrastructure, manpower and boat contract during mid May 2019. A total of ~700 km length of coastline completed. The survey from Krishnampatnam port to Rameshwaram which includes Palk Bay area has been completed successfully. The shallow water bathymetry survey along West Bengal was started Nov-2020 and completed successfully in all respect during Feb-2022. The survey along Andhra Pradesh coast was started during Nov-2021, survey between Krishnapatnam to Odisha border has been completed and survey between Krishnapatnam to Tamil Nadu border is under progress. Similarly the survey along Odisha coast was started during Mar-2022.

Shallow water bathymetry coverage status

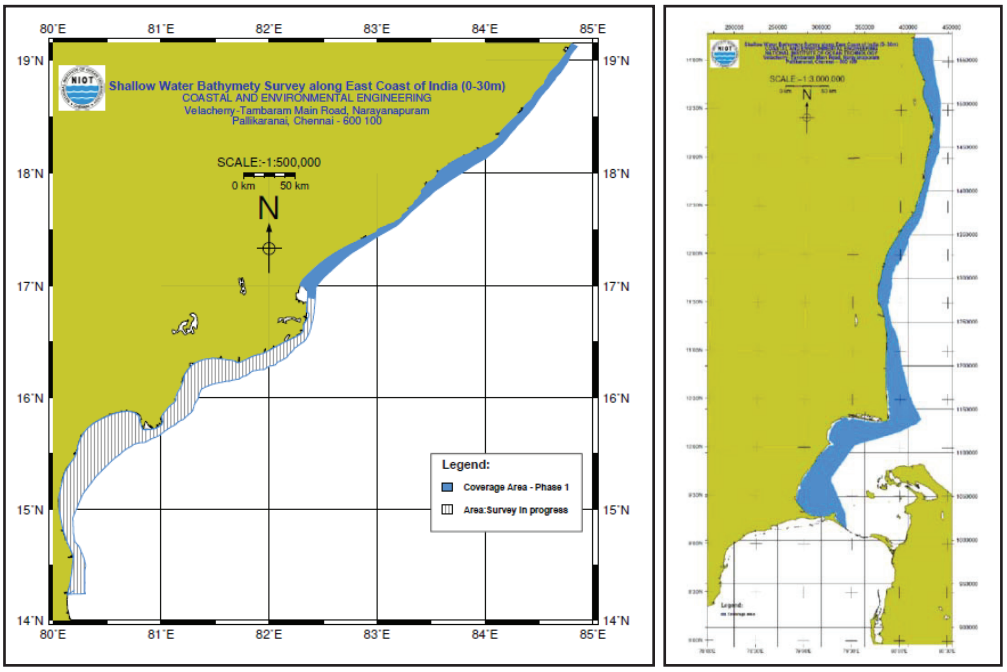
State	Coastline	LKM	%
West Bengal	158	65384	100
Odisha	476	58630	5
Andhra Pradesh	974	61820	60
Tamil Nadu	910	98134	70

Bathymetry coverage during 2021-22

State	Area (km²)	Survey LKM	No of days	No of vessels
West Bengal	2450	16861 (Phase-2)	98	4
Odisha	218	1347	14	4
Andhra Pradesh	4151	25887	109	4
Tamil Nadu	5859	5559	45	3



Bathymetry coverage along West Bengal coast



Bathymetry coverage along Andhra Pradesh and Tamil Nadu coast

INFRASTRUCTURE

8. INFRASTRUCTURE

8.1 ENERGY AND FRESHWATER LABORATORY

An OTEC – Desalination laboratory was set-up at NIOT campus for R&D activities in Ocean Thermal Energy Conversion (OTEC) and Low Temperature Thermal Desalination (LTTD).

OTEC-LTTD Laboratory

The laboratory is capable of conducting experiments related to

- Open Cycle OTEC (OC-OTEC) with Desalination
- Closed Cycle OTEC
- Hybrid closed cycle OTEC with Desalination
- OTEC using Phase change material
- Desalination
- Ocean thermal gradient Island based desalination
- Power plant condenser reject waste heat based desalination

The Laboratory is equipped with a chiller and a heater to simulate the temperature requirements. The OTEC facility can generate 1kW to 2kW of power depending on the cycle and freshwater around 5000L/day. The setup consists of flash chamber, axial flow turbine, shell and tube condenser, and vacuum pump along with instruments. The laboratory is equipped with different sensors to measure the critical process parameters such as temperatures, pressures at various points, turbine speed, power generated, voltage, current etc., through a SCADA integrated system online.

In-house developed turbine

Flash Chamber @11 m height

Control room with SCADA

This laboratory is highly useful for hands-on experience in the operation of OTEC and desalination process and especially for the OTEC powered desalination plant currently underway.

8.2 HYPERBARIC TEST FACILITY (HTF)

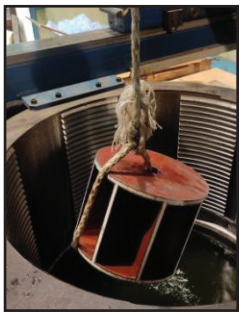
NIOT has a Hyperbaric Test Facility (HTF) to simulate the high pressure conditions of the deep sea environment, inside a high pressure vessel. Components and complete systems which will be used at high depths up to 6000 m (approx.. 600 bar) can be placed inside a test chamber and pressurized externally. The test chamber also has power and instrumentation ports to power the test equipment and online monitoring of the parameters.


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 72s 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 m

Pressure testing of Subsea HPU



Pressure testing of vane impeller Subsea HPU

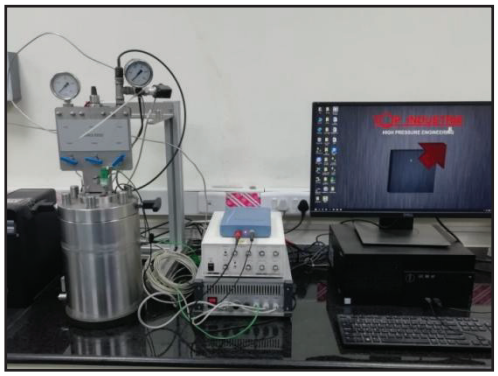
Pressure testing of Subsea Transformer

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:

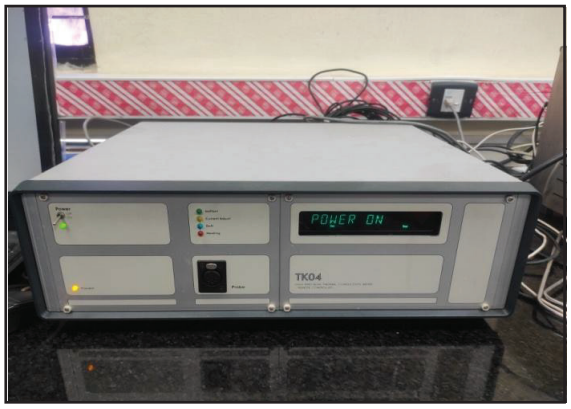
Reactor	High Pressure & Low Temperature
Reactor Capacity	2L
Working Pressure Range	0 to 250 bar
Temperature Range	-50 °C to +50 °C
Thermal Conductivity Range	0.1 - 10 W/mK
Material	Stainless Steel (SS-316L)
Gas Booster	Syringe Pump- Teledyne ISCO 500D
Acoustic Reactor System – Capacity	1L
PicoScope	1MHz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



Acoustic wave velocity measurement reactor

In-situ Thermal conductivity measurement reactor

Gas Booster



Thermal Conductivity Measurement system

Gas Hydrates lab facility at NIOT

8.4 ELECTRONIC SUPPORT FACILITIES, MARINE SENSOR SYSTEMS

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

Shock & vibration test facility

Shaker is used to test the device under 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.

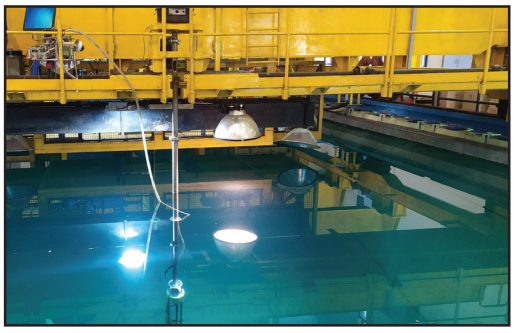
Environmental chamber

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 the test 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 established a state of the art underwater Acoustic Test Facility (ATF) to cater to the needs of underwater acoustic transducer calibration, in the frequency range 100Hz to 500 kHz, for in house project activities and by 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 in the 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 have 3 axes movement.



Acoustic Test Facility for calibration of transducers and other system performance tests

Accreditation

This facility has been accredited in the year 2005 by National Accreditation Board for Testing and Calibration Laboratories (NABL) for calibration of hydrophones and the accreditation is renewed periodically till now. ATF, NIOT carried out Interlaboratory Comparison (ILC) Calibration with the participation of VNIIFTRI, Russia and WTD 71, Germany and successfully completed in October 2014. In 2018, ATF, NIOT participated in Key Comparison Test for hydrophone calibration carried out by NPL UK with 6 six other countries. It has been concluded that the calibration at ATF, NIOT conforms to the international standards and is on par with International laboratories.

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

ACOUSTIC TEST FACILITY OF NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

VELACHERY-TAMBARAM MAIN ROAD, NARAYANAPURAM, PALLIKARANAI, CHENNAI, TAMIL NADU, INDIA

in the field of

CALIBRATION

Certificate Number: CC-2266

Issue Date: 29/09/2021 Valid Until: 28/09/2023

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Identity : ACOUSTIC TEST FACILITY OF NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

ACOUSTIC TEST FACILITY OF NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

PALLIKARANAI, CHENNAI, TAMIL NADU, INDIA

in the field of

TESTING

Certificate Number: TC-5909

Issue Date: 24/05/2021 Valid Until: 23/05/2023

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Identity : National Institute of Ocean Technology

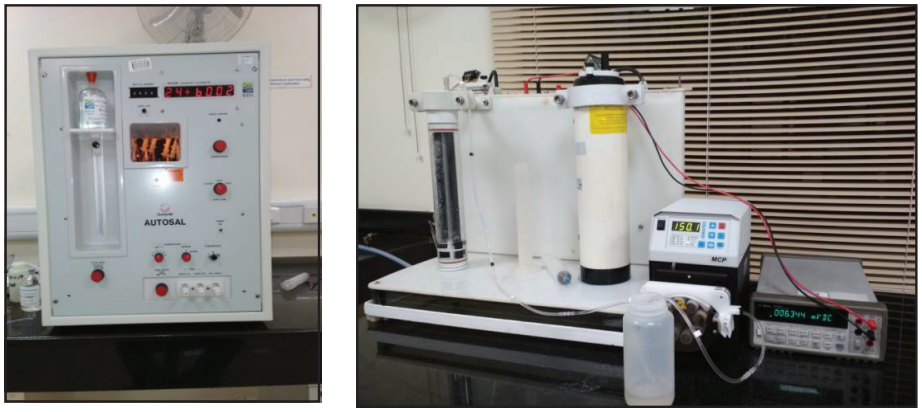
Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

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 setup for salinity and precipitation

8.7 LABORATORY FOR OSTI

OSTI (MBT-Marine Biotechnology) Chennai: Ocean Science and Technology for Island at NIOT Chennai is equipped with various type of instruments for supporting the research activities in marine microbial biotechnology, marine microalgal technology, open sea cage culture and ballast water testing and treatment.

In this endeavour, for imaging the biological specimens a variety of upright and inverted microscopes attached with softwares are installed in the labs. Additionally, the lab is furnished with Scanning Electron Microscope for imaging the ultrastructure of microorganisms. To support the qualitative and quantitative analyses of extracted biomolecules the laboratories do have sophisticated equipment's, like analytical and preparative HPLC, LC-MS, GC and GC-MS. For spectroscopic investigations of isolated biomolecules the laboratories are housed with UV-visible wavelength spectrophotometers, multimode microplate readers, polarimeter, spectrofluorimeter and FT-IR. To decipher the molecular characteristics of the isolated novel microorganisms the lab is provided with gradient and RT PCR. OSTI lab has the facility for mass culture of microalgae in Photobiorectors, Pilot scale raceway ponds etc. A unique high pressure low temperature sampler and cultivation system for isolation and culture of deep sea microorganisms is available in the Department. In the pursuit of testing the anticancer property of the isolated biomolecules there is a cell culture facility equipped with laminar flow hoods, CO_2 incubators, microscopes, electroporator, cold room, freezers, and cryopreservation containers. OSTI has bioinformatics facility for maintaining updated databases on nucleic acids and protein sequences and subsequent analytical modelling.

Thermo Scientific UltiMate 3000 HPLC and UHPLC systems

High Pressure serial dilution system and fermentor

Joel JSM-IT500 In Touch Scope™ Scanning Electron Microscope

ACOSTI-Port Blair: Atal Center for Ocean Science and Technology for Islands (ACOSTI) is field cum marine biological laboratory situated in sprawling 20 hectares campus encompassing 16 hectares 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's, and advance analytical equipment's and laboratory for carrying out research in marine biology and biotechnology.

8.8 COMPUTER MAINTENANCE CELL

The Computer Maintenance Cell (CMC) of NIOT, 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 LAN which caters close to 500 users. LAN has been designed with a single-mode fibre OFC backbone offering aggregate bandwidth of 1 Gbps.

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

CMC support during lockdown period

Keeping organizational interest as the top priority, CMC continued to operate its team of engineers, amidst Covid lockdowns. Teams for direct support, remote support and emergency support have been identified and tasks were assigned. Within the limits of its skeletal manpower,

and remote support, without compromising the quality. Moreover, services were taken up promptly to the required users. Though the support centre was manned by limited manpower, enforcing social distancing, the team took up the challenge of providing service to the users in need. The servers were monitored for their performance physically and remotely, corrective actions were taken wherever required by arranging required spares. Despite challenges, the team managed to provide services to 2226 calls of varied nature like software, IT hardware, OS and network etc. The severity of calls ranged from critical servers to desktops and laptops during the year 2021-22. In addition, efforts have been put forth to carry out patch installation, review critical system logs, report sensitive information stored on systems, maintain user access administration, disaster recovery planning, physical security, disable unnecessary services on servers, and generate/retain system backups and Network Management.

Tele-Presence Facility

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 in the Guest House facilities.

International Seabed Authority (ISA) Training

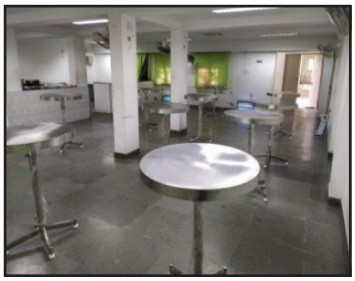
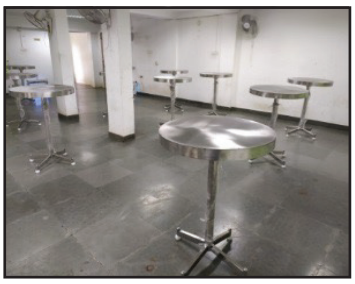
Coordinated the conduct of several online meetings and training, especially the smooth conduct of 7 weeks ISA online training programme from January 17, 2022 to March 4, 2022 which was a contractual obligation to International Seabed Authority by MoES is worth mentioning. To flawlessly conduct the training programme, internal training was conducted for CMC staff, necessary patches were installed on the servers, online meeting software, and a redundant failover setup was made to handle emergencies. As part of the training, a unique web portal was developed for the training with due security systems in place and exclusive access to 15 candidates from different countries spanning from South East Asia to South America. The same web portal facility was extended to the trainers too. The training coordinators from four participating institutes appreciated the interactions with them, the easy and hassle-free conduct of the sessions and secure access to the recorded sessions, which they were encouraging their younger scientists to go through and follow. The feedback from the training candidates conveyed the feeling that NIOT's training has met their aspirations and kindled interest in the training areas. By devoting an altruistic and selfless attitude, the CMC team continued to provide the best of its services to NIOT users.

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, following civil & interior activities have been completed as listed below.

Civil works

Providing SS standing table for Canteen at NIOT campus



Design and execution of civil works for Battery storage and facility for S&GH group at Utility building-II

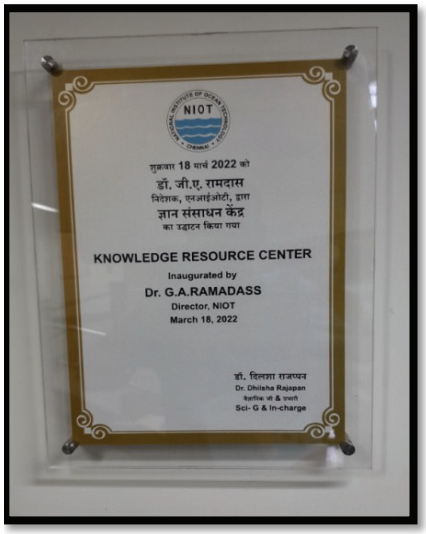
Other activities at NIOT Campus

- Disinfection and sanitization of Campus has been carried out periodically as per SOP issued by Ministry of Home affairs, Ministry of Health and Family Welfare and DoPT., and State Govt., norms to contain the spread of COVID19.
- Booster dose Vaccination Camp conducted at NIOT campus.

Booster Dose Vaccination Camp


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 centre was inaugurated by Director, NIOT on 18th March 2022. 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 oceanographic, biotechnology, and engineering discipline. KRC holding an excellent print collection of over 5650 volumes of books including scientific thesis, reports, NHO Maps, Administrative and Hindi books. KRC subscribes 23 scientific e-journals, available "24 x 7" in real time on institute-wide network and off-campus access to e-resources through Samudra.

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.

OTHER ACTIVITIES

9. OTHER ACTIVITIES

9.1 IMPLEMENTATION OF OFFICIAL LANGUAGE

While dealing with the developing of reliable indigenous Technology for sustainable utilization of Ocean Resources and development, NIOT being a technical institute, has always endeavored in making use of the Official Language hand in hand. The Scientific/Technical reports and publications are also translated in Tamil (the regional language) as well as in Hindi (Official Language). The trilingual policy has been set as a mission for accomplishment and efforts are made for achieving this mission by exploring new avenues for the effective conjunction of the scientific work with the regional and official languages.

Hindi Training

In compliance with the rules for implementing Official Language Policy, training in Hindi for all the employees is done on regular basis with the assistance from HTS officials. Out of the existing 190 incumbents,144 (i.e.75.78%) have attended the training in Hindi. They are given incentives of personal Pay and cash award as per the policy of the Government for incentivizing the learning of Hindi. During this year, 16 staff members had enrolled for the regular training program conducted by the Hindi Teaching Scheme. (Prabodh-6 and Praveen10) and they have completed the same successfully. All the efforts are sincerely made to train all the remaining employees at the earliest.

Hindi Typewritng Course

Employees eligible for typewriting course are enrolled periodically for the same. In the current year, two (2) employees were nominated for Hindi typewriting course. Due to covid-19, classes are organized online and the sponsored employees are assisted and guided by the officials in Hindi cell.

Hindi Fortnight Celebrations

NIOT celebrates Hindi fortnight every year to promote the Official Language. During the year 2021-22, it was celebrated with enthusiasm on the Hindi Diwas i.e.14.09.2021. During the Hindi Fortnight from 14th to 28th September, 2021 debate, essay writing, extempore, Handwriting, Quiz, Text-Reading etc. in Hindi were conducted for the employees of NIOT. All the officials actively

took part in the competitions and in the co-ordination activities as well. The competitions were organized in a way to ensure participation of staff members hailing from both Hindi and non-Hindi speaking states. The prizes were earmarked for both the categories separately. Hence, there was healthy competition among all the employees including those from non-Hindi speaking states and everyone participated in the competitions with zeal. NIOT has now implemented an award for the Noting in Hindi for the employees for encouraging them to submit office note/ make correspondences in Hindi.

On the closing day of the Hindi Fortnight, 27th September, 2021. The prizes for the winners of the competitions were distributed. The Valedictory function was held under the chairmanship of Dr.G.A.Ramadass, Director, NIOT.

Hindi Workshops

NIOT conducts Workshops and training in Hindi every quarterly on various topics for the benefit of the Employees. The topics covered were interesting in many aspects, opening up new ideas and thoughts. The topics of the workshops organized in Hindi during this period were on the topic "Hindi in the field of Science", by Shri Priyankar Paliwal, Senior Hindi Officer, CSIR-Central Glass and Ceramic Research Institute, "Importance and challenges of Hindi in present times" Mrs. Gudiya Chaudhary, HoD of Hindi Department, Guru Nanak College. There was active participation and interaction by the staff members. As per the vision of the Hon'ble Prime Minister, for promoting the use of both regional language & Official language a Translation competition was organized among the staff members of NIOT. The Scientists and other officials actively took Part in this competition.

Official Language Implementation Committee meetings

The meetings of the Official Language Implementation Committee (OLIC) to review the progress of work being done in Hindi by the staff members is conducted at regular intervals as per the mandate. The members of the committee put forward their suggestions for the effective implementation of Official Language and steps are taken to implement the same accordingly. Four such meetings of the Official Language Implementation Committee were conducted through Hybrid mode during the year.

Quarterly and half yearly reports for progressive use of Hindi

Quarterly reports (online) on the implementation of Official Language-Hindi are prepared and submitted 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 being submitted in the prescribed format regularly within time.

E-Magazine in Official Language

NIOT launched its first Hindi edition of the 'Samudrika' e-magazine on 16 January, 2020, during inspection by the Second Sub-Committee of Committee of Parliament on Official Language. It was an honor that the Convener of the subcommittee launched the e-magazine in the presence of all the members of the committee. The magazine is now released biannually on a regular basis. The fourth edition of e-samudrika was released on the occasion of closing ceremony of Hindi Fortnight by Director NIOT.

Technical Glossary in Official Language

A technical glossary is being developed with the assistance of a committee constituted with the Scientists and Hindi officials of NIOT. Terminology used in the technical groups and Sections were consolidated and an online version of the draft glossary has been uploaded in Intranet of NIOT for the benefit of the Employees. The copy of the same has been sent to the Ministry for updation at their end.

Participation in TOLIC meetings and competitions

The half yearly meetings of Town Official Language Implementation Committee (TOLIC) are attended by the Head of the Institute. Besides, NIOT represented in various programs and competitions held from time to time. NIOT was awarded 3rd prize by the TOLIC for its performance in progressive use of official language during the year 2020-2021

9.2 CONFERENCES / WORKSHOPS

- **Manned Submersible User workshop** was conducted online on 15 and 16th July 2021 with the participation of various stake holders such as NCPOR, Goa, CMLRE, Kochi, Indian Navy, GSI (Marine Wing), NIO, Goa and Academic institutions.

- Online training of 12 international candidates was undertaken under the PMN Contract with the **International Seabed Authority** during 17 Jan – 04 Mar 2022. The training was coordinated by NIOT, with the participation of NIO (Goa), NCPOR (Goa), INCOIS (Hyderabad) and IMMT (Bhubaneshwar).

- A one-day workshop on **"Sustenance of Ocean Moored buoy Network in Northern Indian Ocean"** was organised by Ocean Observation Systems on 29 March 2022 at NIOT. Speakers from various national institutions discussed the significant contribution of the Indian moored buoy observation towards improving our understanding of oceans and weather system. The workshop was organized in hybrid mode.

- On the occasion of **World Water Day** on 22nd March 2022, an online event on "**Groundwater: Making the invisible, visible"** was organised by KPR Institute of Engineering and Technology, Coimbatore in association with InDA (SZ), SRM-Institute of Science and Technology and NIOT with participation by students from various institutions.

- **An international webinar on "OTEC – Some Developments and Way Forward**" was organised by NIOT under the aegis of OES-TCP on 29th March 2022 with keynote speakers from USA, Japan, South Korea, Malaysia, Indonesia and Netherlands.

OES Webinar on OTEC held on 29th March 2022

Virtual meeting

Dr.G.A.Ramadass, Director, NIOT, attended the 1st Part of the 27th Session of International Seabed Authority (ISA) virtually during 21st March to 1st April 2022 held at Kingston, Jamaica.

9.3 IMPORTANT DAYS OBSERVED AT NIOT

9.3.1 Independence Day Celebration

Independence day was celebrated at NIOT campus and flag hoisting was done by Director NIOT on August 15, 2021 and addressed the gathering.

9.3.2 Republic Day Celebration

NIOT celebrated 73rd Republic Day on 26th January 2022. 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.

9.3.3 Foundation Day of NIOT

Dr.Jitendra Singh, Hon'ble Minister of State (Independent Charge) of the Ministry of Earth Sciences and Ministry of Science & Technology visited NIOT facilities and presided over the NIOT's 28th Foundation day celebration. He also launched the SAMUDRYAAN Indian Manned Ocean Mission under Deep Ocean Mission. Dr.M.Ravichandran, Secretary MoES participated in the event and released E-Samudrika newsletter of NIOT in 3 languages English, Hindi and regional language Tamil. HMoES along with Secretary-MoES, Director NIOT and senior scientists participated in a short cruise onboard ORV Sagar Nidhi and inspected the NIOT fleet of vessels at Chennai Harbour.

9.3.4 International Women's day Celebration

The International Women's Day was celebrated by NIOT on March 8, 2022. Smt.Indira Murthy, Joint Secretary, MoES graced the occasion as the Chief Guest and delivered the Women's day Special address. Dr.G.A. Ramadass, Director NIOT and Dr. R. Krishnan, Director IITM Pune gave Women's day remarks. As part of International Women's Day celebration at NIOT, Cancer awareness program was also organized at NIOT on March 4, 2022 in association with the Cancer Institute (WIA) Adayar for the women employees of NIOT. Competitions such as making of Promo Video on Ocean Technology, Science storytelling, Making wonder from wastes, Performance with Hilarious video clips were organized for the staff and prizes were given to the winners.

- Azadi Ka Amrit Mahotsav - ICONIC week 18-24th Oct.2021 (MoES) was observed by NIOT. Scientists of NIOT participated in the AKAM awareness program and delivered lectures. NIOT organized awareness on Ocean Technology and achievements of NIOT to local school students in regional language. Interactive sessions were organized by Senior Scientists of NIOT to local school students.

- NIOT observed Vigilance awareness week from October 26, 2021 to November 1, 2021 and e-pledge was taken by NIOT staff at their respective work places. As part of this, a workshop is organized and Dr.C.L.Ramakrishnan, Retd. DGP, was invited as the Chief guest and delivered a lecture on 'Independent India @75: Self Reliance with Integrity' on 27th October 2021. Competitions such as quiz and debate were also conducted for NIOT staff.

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 2021 and January-February 2022. Management Review Meetings were conducted during August 2021 and February 2022 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 Recertification 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 22.09.2021 and the validity of ISO certification has been extended upto 08.11.2024.


ZERTIFIKAT ◆ CERTIFICATE ◆ ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

CERTIFICATE

The Certification Body
of TÜV SÜD South Asia Private Limited
certifies that

National Institute of Ocean Technology
(Ministry of Earth Sciences, Govt. of India)
NIOT Campus, Velachery - Tambaram Road,
Narayanapuram, Pallikaranai Chennai - 600 100, Tamil Nadu, INDIA

has implemented Quality Management System
in accordance with ISO 9001:2015
for the scope of

Providing Supporting services like Strategic Planning and Management, Finance and Accounts, Stores and Purchase, Establishment and Personnel, Estate and Maintenance, Library, Director's Secretariat, Computer Maintenance Cell, Security, Transport and Logistics, Human Resource Development to Ministry of Earth Sciences

The certificate is valid from 2021-11-09 until 2024-11-08
Subject to successful completion of annual periodic audits

Certificate Registration No. 99 100 21910
Date of Initial certification: 2006-12-13
Issue Date: 2021-10-13 Rev. 00

Rahul Kale
Head of Certification Body
of TÜV SÜD South Asia Private Limited,
Mumbai
Member of TÜV SÜD Group

9.5 VISIT OF DIGNITARIES

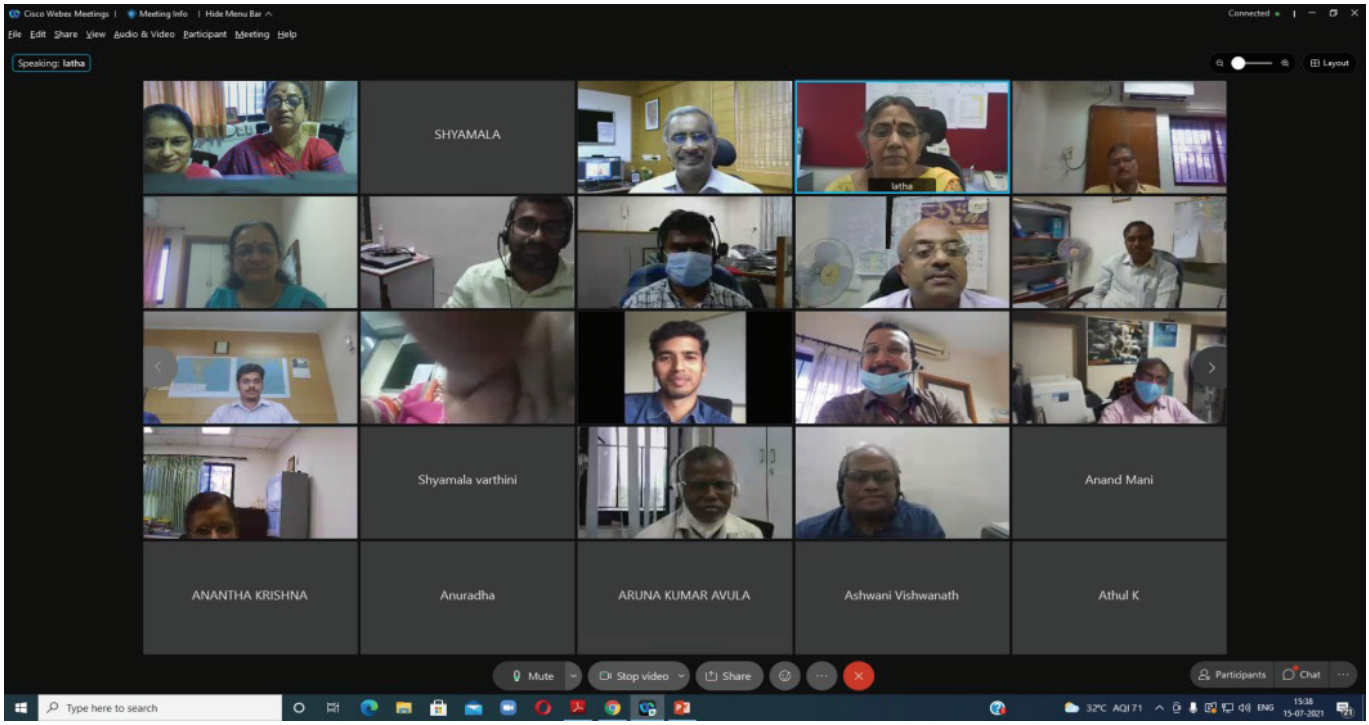
- On 30th October 2021, Dr.Jitendra Singh, Hon'ble Minister of State (Independent Charge) of the Ministry of Earth Sciences and Ministry of Science & Technology, visited Chennai Port and reviewed the Research Fleet of MoES/NIOT. He boarded the Ship ORV Sagar Nidhi, India's pride and a state of art ice-class research vessel of the sub-continent and went on a short cruise during which, he reviewed the scientific & technology demonstration capabilities of the Ships. All four research vessels under NIOT/MoES viz., ORV Sagar Nidhi, ORV Sagar Manjusha, CRV Sagar Tara & CRV Sagar Anveshika made a formation off-Chennai Port as part of NIOT Research Fleet review by the Hon'ble Minister. The Hon'ble Minister praised the valuable contribution of these Research Ships towards the enhancing the knowledge on oceans.

- Bhoomi Pujan ceremony was performed on 31 March 2022 by Shri Praful Patel, Administrator, UT Lakshadweep, in the presence of Dr. G.A. Ramadass, Director, NIOT and members from both NIOT and Lakshadweep administration.

Bhoomi Pujan ceremony performed by Shri Praful Patel, Administrator, Lakshadweep

9.6 SWACHHATA PAKHWADA

Swachhata Pakhwada Celebrations at NIOT were held during July 1-15, 2021. Cleanliness campaign inside the NIOT campuses at Chennai, Atal Centre for Ocean Science and Technology in Islands (ACOSTI), Port Blair and Seafront Facility at Nellore was conducted. Steps were taken to follow all the CoVID protocols such as wearing of mask, hand gloves and use of hand sanitizers. Competitions such as 'Work Space & hygiene' for admin staffs, 'Assessing the Aesthetics of NIOT Labs', Talk for 'Clean / Sustainable Technologies - Assessment and Implementation' for Scientists, and drawing competition for school children from 7th to 12th std were conducted as part of Swachhata Pakhwada. Director Dr. G.A. Ramadass presided over the Swachhata Pakhwada Valedictory Function held on 15th July 2021, NIOT, Chennai.




Before cleaning and after cleaning at NIOT Campus, Chennai


Before cleaning and after cleaning at Minnie Bay, Port Blair


Beach front at Seafront site of NIOT Pamanji, Andhra Pradesh

10. AWARDS / RECOGNITIONS

- VMC team augmented scientific facilities onboard Sagar Nidhi & Sagar Manjusha in all aspects for uninterrupted scientific data collection. This has fetched **Certificates of Merit** from India Meteorological Department [IMD] for Sagar Nidhi / Sagar Manjusha in recognition of the 'Commitment to Excellence & Commendable contributions towards Climate Research' by collection of Meteorological data.

Certificate of Merit bestowed to Sagar Nidhi & Sagar Manjusha

- Shri. Biswajit Haldar, Sci- C, and co authors received **best paper award** for paper titled "Effect of Mooring Motion on Temperature Profile Measurements in OMNI Buoy Systems- A Case Study" OSICON 2021 Conference held during 12th-14th August 2021.

11. PATENTS / TRANSFER OF TECHNOLOGIES (TOT)

Patents Awarded

S.No.	Inventors	Title	Awarded reference	Country
1	Purnima Jalihal, Sudha D, Ashwani Vishwanath	A System for pumping cold water deploying Permanently Moored Floating Conduit from deep sea	365861 Dt.30.4.2021	India
2	Meena B, Anburajan L, Vinithkumar N.V, Dharani G, Kirubagaran R	A process for detecting virulent genes of Enterococcus faecalis and a detection kit thereof	367008 Dt.19.5.2021	India
3	Venkatesan R, Arul Muthiah M, Sundar R, Ramesh K	Real Time Tsunami Monitoring System	369964 Dt.22.6.2021	India
4	Sundar, Srinivasan R, Ramadass G.A, Atmanand M.A	A system and method for calibrating acoustic tide gauge	371442 Dt.8.7.2021	India
5	Venkatesan G, Samson, Raju Abraham, Purnima Jalihal	Multi interconnected compartment device with heat exchangers for the production of drinking water from low temperature fluid streams	379234 Dt.12.10.2021	India
6	Purnima Jalihal, Ashwani Vishwanath	Multi-functional Interface System for connecting floating structures	382215 Dt.22.11.2021	India
7	Tata Sudhakar, Shijo Zacharia, Thamarai T, Gowthaman V, Atmanand M.A	Automated Tsunami Test Rig	385571 Dt. 30.12.2021	India
8	Mary Leema Thilagam, Magesh Peter, Kumar T.S, Thirupathi K, Dharani G, Kirubagaran R, Atmanand M.A	Process for the production of Lutein	No.390089 Dt. 23.2.2022	India

Patents Filed

S. No.	Inventors	Title	Filed Application no.	Country
1	Venkatesan G, Purnima Jalihal, Srinivasa Rao S, Samson Packiaraj, Abhijeet Sajjan, Trisahnu Shit, Karthikeyan A	Eco-Friendly Ocean Thermal Energy Conversion System for Production of Potable Water and Electrical Energy	TEMP/E-1/35804/ 2021-CH Dt. 20.7.2021	India
2	Anburajan L, Meena B, Vinithkumar N.V, Kirubagaran R, Dharani G	Recombinant Ectoine: A major compatible solute from halophilic bacteria Bacillus clausii	202141056903 (TEMP/E1/64548/ 2021CHE) Dt. 07.12.2021	India
3	Venkatesan R, Ramesh K, Arul Muthiah M, Thirumurugan K	Intelligent Rain Gauge and Method Thereof	202141056904 Dt. 7.12.2021	India
4	Muthuvel.P, Sarojani Maurya, Tata Sudhakar	Variable Buoyancy engine for submersible platform	202241003710 (TEMP/E-1/3437/ 2022-CHE) Dt.22.1.2022	India
5	Venkatesan R, Arul Muthiah M, Kesavakumar B, Thirumurugan K, Vengatesan G, Muthukumar C	Artificial intelligence based autonomous data acquisition system and method for deep ocean and subsea environments	202241005052 Dt.31.1.2022	India
6	Venkatesan R Arul Muthiah M, Kesavakumar B, Vengatesan G, Ramesh K	Smart autonomous system for real-time monitoring and data acquisition for marine applications and method thereof	202241005053 Dt. 31.1.2022	India

Transfer of Technologies (ToT) to Industries

As a part of Indigenous technology developments, many 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.	Biosurfactant from Marine Bacteria for Environmental cleanup and Waste management	M/s Eco BuildCorp Private Limited, Bangalore	July 2021
2.	Robo Coastal Observer (RCO)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
3.	Robo Boat (RB)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
4.	Met-Ocean Buoy System type – I (MOBS-1)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
5.	Met-Ocean Buoy System Type-2 (MOBS-2)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
6.	Indian Tsunami Buoy System Type-1 (ITBS-1)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
7.	Indian Tsunami Buoy System Type-2 (ITBS-2)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
8.	Autonomous Underwater Profiling Drifter 200 m of water depth Argo Floats (AUPD)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
9.	Ocean Drifter Buoy With INSAT Communication (DBS)	M/s. Larsen & Toubro Limited, Mumbai	August 2021
10.	Marine Oil Spill Bioremediation Technology	Eco build corp. Pvt. Ltd, Bangalore.	September 2021
11.	Recombinant Ectoine from deep-sea Bacteria for skin-care and cosmetic applications (REB)	M/s. Ambtus Lifesciences on Recombinant Ectoine Technology	January 2022

12. PUBLICATIONS

International Journals

1. Rishav, R., Anandanarayanan, R., Suchithra, R., Dudhgaonkar, P., Samad, A., "*Wave energy harvesting impulse turbine having ring type blade: Experiments with unsteady flow*", **Journal of Ocean Engineering,** 236, 2021.

2. S. Mandal, S. Sil, A. Gangopadhyay, B. K. Jena, R. Venkatesan, G. Gawarkiewicz, *"Seasonal and Tidal Variability of Surface Currents in the Western Andaman Sea Using HF Radars and Buoy Observations During 2016–2017,"* in **IEEE Transactions on Geoscience and Remote Sensing,** Vol. 59 (9), pp. 7235-7244, September 2021, doi: 10.1109/TGRS.2020.3032885.

3. Prince Prakash Jebakumar Jebarathnam, Ragumaran, S., Nandagopal, G., Vijaya Ravichandran, Ramana Murthy Mallavarapu, Thomas M. Missimer, *"Green method of stemming the tide of invasive marine and freshwater organisms by natural filtration of shipping ballast water"*, **Environmental Science and Pollution Research**, 28: 5116–5125, 2021.

4. Dilip Kumar, J., Pandey Vikas, Santhanakumar J., Sathish Kumar P., Venkatnarayanan S., Prince Prakash Jebakumar J., Dharani G., Vijaya R, *"Evaluation of Site Suitability for Artificial Reefs Deployment in Southeast Coast of India Using Geographical Information System as a Management Tool*", **Frontiers in Marine Science**, January 2022, https://doi.org/10.3389/fmars.2021.817975.

5. Vikas Pandey, Dilip Kumar Jha, P. Sathish Kumar, J. Santhanakumar, S. Venkatnarayanan, J. Prince Prakash Jebakumar, G. Dharani, *"Effect of multiple stressors on the functional traits of sub-tidal macrobenthic fauna: A case study of the southeast coast of India"*, **Marine Pollution Bulletin**, Vol.175: 113355, February 2022, https://doi.org /10.1016 / j.marpolbul.2022.113355.

6. Prince Prakash JebakumarJebarathnam, Ganesan Nandhagopal, Bose Rajan Babu, Shunmugavel Ragumaran, Appukuttan Santhakumari Kiran, and Vijaya Ravichandran *"Ecological Appraisal of Geotextiles in Coastal Erosion Protection Engineering,"* **Journal of Coastal Research**, Vol.38 (2), 345-354, March 2022.

7. Prince Prakash Jebakumar Jebarathnam., Nandhagopal, G., Ragumaran, S., Vijaya Ravichandran, Ramakritinan, C. M., *"Artificial coastal defence structures – A surrogate of natural rocky structure to enhance coastal biodiversity"*, **Journal of Earth System Science**, 130, 127, June 2021.

8. Prince Prakash Jebakumar Jebarathnam, Nandhagopal, G., Babu, B.R., Ragumarn, S., Dilip Kumar Jha, Santhana Kumar, J., Dharani, G., Vijaya Ravichandran. (2021) "*A Looming Chance of Bio Invasion by a Bryozoan Amathiaverticillata Among the Sea Fan and Seagrass Population Along Tamil Nadu Coast: A Case Study",* **Proceeding of the Zoological Society**, Vol.75, 173-180, September 2021, https://doi.org/10.1007/s12595-021-00387-1

9. Bose Rajan Babu, Ganesan Nandhagopal, Prince Prakash Jebakumar Jebarathnam, Shunmugavel Ragumaran, Chokalingam Muthaiah Ramakritinan, *"Eco-friendly approach in strengthening the different grain size particles by utilizing Sporsarcinapausterii NIOT1"*, **Research Journal of Chemistry and Environment**, 25 (12): 137-141, 2021.

10. Mousumi Dey, Shanmuga Priyaa Sand Basanta Kumar Jena, "*A Shoreline Change Detection (2012-2021) and forecasting Using Digital Shoreline Analysis System (DSAS) Tool: A Case Study of Dahej Coast, Gulf of Khambhat, Gujarat, India"*, **Indonesian Journal of Geography**, Vol.53 (2), 2021. https://doi.org /10.22146 /ijg. 56297.

11. Ganesh Kumar, A., Manisha, D., Sujitha, K., Magesh Peter D., Kirubagaran R., Dharani G, *"Genome sequence analysis of deep sea Aspergillussydowii BOBA1 and effect of high pressure on biodegradation of spent engine oil"*, **Nature Scientific Reports** 11, 9347 (2021), Nature.

12. A. Ganesh Kumar, M. Hinduja, K. Sujitha, N. Nivedha Rajan, G. Dharani, *"Biodegradation of polystyrene by deep-sea Bacillus paralicheniformisG1 and genome analysis"*, **Science of The Total Environment**, 774, 2021, Doi: 10.1016/j.scitotenv.2021.145002.

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14. J.Santhanakumar, C.Sureshkumar, Dilip Kumar Jha, G. Rajaprabhu, P.Venkateshwaran, R. Sendhil Kumar, G.Dharani, R. Kirubagaran, M. A. Atmanand, *"Comparative assessment of fish assemblages around open sea cages vis-a-vis common fishing ground"*, **Journal of Earth System Science**, 130, 124, June 2021, doi: 10.1007/s12040-021-01626-x.

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17. Goswami, P,Vinithkumar, N.V., Dharani, G, *"Microplastics particles in seafloor sediments along the Arabian Sea and the Andaman Sea continental shelves: First insight on the occurrence, identification and characterization"*, **Marine Pollution Bulleti**n, 167: 112311, 2021.

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19. Dilip Kumar Jha, Pandey V, Santhanakumar J, Sathish Kumar P, Venkatnarayanan S, Jebakumar JPP, Dharani G and Vijaya R., *"Evaluation of Site Suitability for Arti□cial Reefs Deployment in Southeast Coast of India Using Geographical Information System as a Management Tool"*, **Frontiers in Marine Science**, January 2022, 8:817975. doi: 10.3389/fmars.2021.817975.

20. Ratnam K, Dilip Kumar Jha, Prashanthi Devi M, Dharani G, *"Evaluation of Physicochemical Characteristics of Coastal Waters of Nellore, Southeast Coast of India, by a Multivariate Statistical Approach"*, **Frontiers in Marine Science**, March 2022, 9:857957. doi: 10.3389/fmars.2022.857957.

21. S.Priyanka., Kirubagaran. R, Mary Leema. J. T, "*Optimization of ultrasound-assisted extraction of zeaxanthin from marine microalgae Dunaliellatertiolecta (NIOT 141) using response surface methodology"*, **Research Journal of Pharmacy and Technology**, Vol. 14, No. 03, pp. 1729-1735, 2021.

22. Meena, B., Anburajan, L., Nitharsan, K., Vinithkumar, N. V., Dharani, G, "*Existence in cellulose shelters: industrial and pharmaceutical leads of symbiotic actinobacteria from ascidian Phallusianigra, Andaman Islands"*, **World Journal of Microbiology and Biotechnology**, 37, 120, 2021.

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49. K.Chithra, R.Kokila, D.S.Sreedev, M.Sankar *"A method to Calibrate phased Hydrophone Array Elements in Near field",* **Proc. of IEEE OCEANS 22,** IIT Madras, February 21-24, 2022.

50. A.Thirunavukkarasu, G.Latha and Shanmuga Sundaram K, *"Design of a subsea pressure housing for the ambient noise measurement system in the Arctic region",* **Proc. of IEEE OCEANS 22,** IIT Madras, February 21-24, 2022.

51. Madan M. Mahanty, G.Latha, M.C.Sanjana, G.Raguraman and R.Venkatesan *"Passive acoustic detection of distant ship crossing signal in deep waters using wavelet denoising technique",* **Proc. of IEEE OCEANS 22,** IIT Madras, February 21-24, 2022.

52. Noufal K.K., Sanjana M.C., Sunil Kumar Mohanta, Shweta Lokhande and G. Latha, Gopu R Potty and James H. Miller, *"Sediment Parameter Inversions in the East China Sea",* **Proc. of IEEE OCEANS 22,** IIT Madras, February 21-24, 2022.

53. Vikas Pandey, S. Venkatnarayanan, P. Sathish Kumar, Krupa Ratnam, Dilip kumar Jha, S. Rajaguru, G. Dharani, *"Multivariate approach for evaluating the significant sources influencing the variation of coastal water quality in Swarnamukhi river estuary, Nellore, India",* poster presented in **Proc. of IEEE OCEANS 22**, IIT Madras, February 21-24, 2022.

54. Venkatnarayanan. S, Sathish Kumar. P, Vikas Pandey, Krupa Ratnam, Dilip Kumar Jha, Kumar. T.S, Rajaguru. S, Dharani. G, "Effect of constant darkness on the survival of planktonic organisms – with implications on ballast water management", poster presented in **Proc. of IEEE OCEANS 22**, IIT Madras, February 21-24, 2022.

55. Sathish Kumar P, S. Venkatnarayanan, Vikas Pandey, Krupa Ratnam, Dilip Kumar Jha, S. Rajaguru, G. Dharani, *"Phytoplankton abundance and its implication in ballast water management system in Indian scenario",* poster presented in **Proc. of IEEE OCEANS 22,** IIT Madras, February 21-24, 2022.

National Conferences

1. Ashwani Vishwanath, Biren Pattanaik, K S Sajeev, Y V N Rao, A Karthikeyan, *"Ocean observation buoy powered using wave energy",* **Seventh National Conference of the Ocean Society of India – OSICON 2021**, Goa, August 12-14, 2021.

2. Y V N Rao, Biren Pattanaik, Purnima Jalihal, *"Understanding the pressure measurement in multi-phase of Open Cycle OTEC power Plant",* **Seventh National Conference of the Ocean Society of India – OSICON 2021**, Goa, August 12-14, 2021.

3. Shanmuga Priyaa S, Aruna Kumar Avula, Basanta Kumar Jena. *"Decadal Shoreline Morphological Changes using Satellite Images of Goa Coast"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021**, Goa, August 12-14, 2021.

4. Muhammed Naseef. T, J. Rajkumar and Basanta Kumar Jena, *"Sensitivity analysis of wave hindcasts for the design criteria for engineering applications",* **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

5. Srinivasan Sundararajan, Mukunda Kesari Khadanga, Balasubramanian Kamalakannan, Asim Amitav Pattanayak, Basanta Kumara Jena, "*Accumulation of Petroleum Hydrocarbons in Zooplankton at Nagapattinam coastal water, Bay of Bengal, South East coast of India",* **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

6. Balasubramanian Kamalakannan, Srinivasan Sundararajan, Basanta Kumara Jena, Asim Amitav Pattanayak, Mukunda Kesari Khadanga, "*The Preliminary study of coastal water acidi_cation monitoring in the Palk Bay, Southeast coast of India",* **Seventh National Conference of the Ocean Society of India – OSICON 2021**, Goa, August 12-14, 2021.

7. Mukunda Kesari Khadanga, Balasubramanian Kamalakannan, Asim Amitav Pattanayak, Srinivasan Sundararajan, Basanta Kumara Jena, *"Evaluation of the heavy metal pollution in the estuarine ecosystem of Tapi and its sustainable management, Arabian Sea"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021**, Goa, August 12-14, 2021.

8. Srinivasan. R., Boby George, Tata Sudhakar, Ramadass. G.A., "*Conductivity sensor for marine applications based on capacitive coupling technique"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

9. Gowthaman.V, Shiva Prasad.G, Tata Sudhakar, *"Performance of C' Profiler during Sea Trial"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

10. Sarojani Mauriya, Muthuvel.P, Tata Sudhakar *"Development and Field results of autonomous underwater profiler drifter"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

11. Bolem Srinivas, NiteshVarma, Arathy Nair, Muthukumaravel, Dharani and Tata Sudhakar. "*Applications of Artificial Intelligent and Machine Learning (AIML) in Fish Bio mass estimation system"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

12. Sunil Kumar Mohanta, G.Latha, M.C.Sanjana, E. Arunbabu, *"Soundscape in Summer in Kongsfjorden, Arctic"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

13. Shweta Lokhande, G Latha, S Srinivasan, A. Malarkodi, *"Comparison of Vector Sensor Array processing algorithms for underwater source Localization"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021**, Goa, August 12-14, 2021.

14. R. Janani, G.Latha, M.Krishnaveni, and R.Venkatesan, *"Study of wave spectral characteristics in deep water region in the southern Bay of Bengal"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

15. Reddy Janakiram, G.Latha, R.Balamurugan, and R.Venkatesan, *"Wave spectral characteristics in shallow waters off Goa coast during pre and post-monsoon seasons"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

16. R.Keerthivasan, G.Latha, R.Balamurugan, and R.Venkatesan, *"Wave spectral characteristics of Two concurrent cyclone Kyarr and Maha in the Arabian sea"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

17. Biswajit Haldar, Abhishek Tandon, K.Jossia Joseph, M.Arul Muthiah, P.Senthil Kumar, R.Venkatesan, *"Effect of Mooring Motion on Temperature Profile Measurements in OMNI Buoy Systems: A Case Study"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

18. Anoopa Prasad C., Martin V. Mathew, K. N. Navaneeth, K. Jossia Joseph and R. Venkatesan, *"Intense upwelling in the southeastern Arabian Sea during the post-monsoon season"*, **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

19. B.Kesavakumar, G.Vengatesan, M. Arul Muthiah, R. Venkatesan, *"Air Quality Monitoring from Deep Ocean Moored buoy systems in the Indian Ocean",* **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

20. Martin V. Mathew, K. N. Navaneeth, Anoopa Prasad C., K. Jossia Joseph and R. Venkatesan, 2021, *"Characteristics of Diurnal Sea Surface Temperature Variability in the North Indian Ocean and its Implications to Air-Sea fluxes"* **Seventh National Conference of the Ocean Society of India – OSICON 2021,** Goa, August 12-14, 2021.

21. Divya David T, Subeesh M. P, Kesavakumar B, Archana Singh, Ravichandran M, Arul Muthiah, R Venkatesan, *"Five years of IndARC mooring–science and technology",* **Seventh National Conference of the Ocean Society of India – OSICON 2021**, Goa, August 12-14, 2021.

14. INVITED TALKS

Dr.G.A.Ramadass

- "Technology for the exploration of Ocean Resources", India's Scientific Endeavour in the Exploration of Ocean Resources Organized by National Maritime Foundation, May 11, 2021.

- "Blue economy - Indian way", IOCINDIO- Indian Ocean Blue Economy Summit Webinar on Blue Economy in the Indian Ocean region towards UN Decade of Ocean Science for Sustainability (2021-2030), May 6, 2021.

Dr.Purnima Jalihal

- "Potential and Developments in Ocean Renewable Energy and Fresh Water towards powering Blue Economy in India", ICOE 2021, April 28, 2021.

- "Ocean Technology – The Indian Scenario", AMET University, June 25, 2021.

- "Ocean Renewables" in the Asia Pacific Region, July 7, 2021

- "Ocean Thermal Desalination", AICTE ATAL FDP, NIFFT, Ranchi, August 13, 2021.

- "Desalination – Types, Challenges and Energy", AICTE ATAL Faculty Development Programme, Anna University, Dindigul Campus, August 25, 2021.

- "Green Energy and Clean Water from the Oceans", PRL ka Amrut Vyakhyan, September 15, 2021.

- "Energy and Water from the Oceans for the Mitigation of Climate Change Impact" – Climate change, Urbanization & Multi-Hazard Management, NIOM, September 21, 2021

- "Energy and Underwater Technologies under the Blue Economy Framework", Institution of Naval Architects India, September 25, 2021.

- "Non-conventional Desalination Technologies", AICTE, ATAL FDP, SRM University, October 7, 2021.

- "Clean Energy and Ocean Thermal Gradient – The Indian Scenario", Ocean Thermal Energy Association webinar, October 8, 2021.

- "Can Desalination Alleviate the Water Stress", IITDM FDP Kancheepuram, October 26, 2021.

- Chief Guest Address for INCOIS Women's Day Celebration, March 8, 2022.

Dr. R.Venkatesan

- Delivered a lecture on "Operational Oceanography in Africa-Role of Weather, Climate and Coastal Hazards Operational Oceanography role of in-situ observations", GOOS AFRICA on June 8, 2021.

- Delivered a lecture on "Ocean Observation System- Present & Future Context Bay of Bengal" organized by National Oceanographic and Maritime Institute (NOAMI), Ministry of Science and Technology, Govt. of the people's republic of Bangladesh, on June 17, 2021.

- Delivered a Tamil lecture on "Plastic Pollution in Ocean" as part of Swachhta Pakhwada through webinar and this talk was hosted by Ariviyal Palagai on July 14, 2021.

- Delivered a live talk at Marine Technology Society (MTS) virtual Symposium titled "Women Leadership Programme in Marine Technology Engineering and Science" on September 14, 2021.

- Delivered a talk during the UN Decade Predictive Ocean Laboratory II - virtual mode, invited by Federal Government of Germany and UNESCO IOC, September 15-17, 2021.

Dr.D.Rajasekhar

- As a Key note speaker, delivered a technical talk on "Role of Research Ships to foster Greener & Cleaner Oceans" at SSN College of Engineering, as part of World Ocean Day, June 8, 2021.

Dr. G. Latha

- "Swachh Bharat – Swachh Sagar – Ocean noise" – during Swachhata Pakhwada, KVCLRI Adyar, Chennai, July 17, 2021.

- "Soundscape of the Kongsfjorden Arctic", in the National Symposium on Acoustics (NSA 2021-22) organized by Acoustical Society of India and CSIR-National Physical Laboratory , through virtual mode during March 3-4, 2022, at CSIR-NPL, New Delhi.

- "Women in Engineering", Panelist in the session in International conference Oceans 2022 held at IIT Madras, Chennai during February 21-24, 2022.

Dr.Vijaya Ravichandran

- Delivered an invited talk on "EIA & EMP for dredging" at the Online training program on dredging management for port officials by Indian Maritime University, held during December 6-10, 2021.

- Delivered an invited talk on 'An overview of Marine Pollution (Concept, Sources, Types, Consequences) & Current Practices to control Pollution' as part of training course on Environmental Management and Pollution Control organized by Indian Maritime University, March 28 to April 1, 2022.

Dr. Basanta Kumar Jena

- Delivered a lecture on "Numerical modeling for hydrodynamics" for Ph. D students of IMU during 25th June to 08th August 2021.

- Delivered an invited talk on "Coastal Engineering and coastal process" for IIT Madras M.Tech OE2 students, August 16, 2021.

- Delivered an invited talk on "Introduction to Coastal Engineering" at NIH online exposure session on 24 and 27 August 2021.

- Delivered a talk on "Tsunami and Cyclone Events" at the online in UGC-STRIDE-IRCECCB's 2nd Winter school on "Contemporary Environmental Issues" October 31, 2021.

- Delivered a talk on "Tsunami detection using HF Radar surface" at the online in UGC-STRIDE-IRCECCB's International Virtual Symposium "Outcomes of the conference of the practices 26 (COP26)", on December 12, 2021.

- Delivered an invited talk on "Progress and Prospects of Hydrographic Surveying Technology in Research and Development" at the online by OSI Webinar Series, January 27, 2022.

- Delivered a talk on "Recovering key species for ecosystem restoration" in UN World Wildlife Day, March 3, 2022.
- Delivered an invited talk on "Indian Coastal Ocean Radar Network (ICORN) and its application" at the online by OSI Webinar Series, March 25, 2022.

Dr.S.V.S.Phanikumar

- Delivered a lecture on "Solar based Desalination for Remote Islands", JNTUA, College of Engineering, Anantapur, September 9, 2021.
- Course on Ocean Technology at Mepco Schlenk Engineering College, December 29, 2021.
- Co-Chair for session in Offshore Structures at International Conference, Oceans 2022, February 23, 2022.

Dr. S. Ramesh

- Delivered a talk on National Webinar "Indian Ocean Paleoceanography: Late glacial – Holocene Period" in the Department of Marine Science, Bharathidasan University, Tiruchirappalli on December 30, 2021.
- Delivered a talk on "Underwater Vehicles for Ocean exploration - Indian Ocean Perspective" at SSN College of Engineering, Chennai during International Workshop on Current Trends and Future Directions in Underwater Communication Explore the unseen v4.0 on February 18, 2022.

Dr.G. Dharani

- Delivered lecture on "Ballast water and invasive species" in the Regional Seminar on Biofouling Management and Invasive Aquatic Species, organised by SACEP & IMP on July 16, 2021.
- Delivered lecture on "Biodiversity of coral reefs in India" in the workshop on Technologies for underwater exploration, organised by Technology Innovation Hub, Indian Institute of Technology, Guwahati on August 31, 2021.

- Delivered lecture on "Bioactive compound from marine organisms" in the workshop on Cutting Edge Technologies in Fisheries and Aquaculture for Food and Nutritional Security (CETFAQ-2021), organized by ICAR NBFGRI on December 17, 2021.

Dr. Prince Prakash Jebakumar

- Delivered an invited talk on "EIA & EMP for dredging" at the Online training program on dredging management for port officials by Indian Maritime University held between 6-10, December 2021.
- Delivered an invited talk on "Functional redundancy of coastal ecosystem restores biodiversity by key epibiotic species assemblage on coastal erosion protection structures along Tamil Nadu & Pondicherry coasts" at United Nations World Wildlife Day celebrations under the theme "Recovering Key Species for Ecosystem Restoration" webinar organized by OSI, NCPOR, NIOT, Ocean School- REEF & YEPT Ocean Conservation Alliance, on March 3, 2022.
- Delivered an invited talk on "Coastal ecosystem response to shore protection structures along Tamil Nadu & Pondicherry coast" at National Conference on Global Marine Biodiversity - status, threats and conservation (ncgmb, 2022) webinar by Department of Zoology, V.V. Vanniaperumal College for Women during 9-10 March 2022.

Dr.D.Sathianarayanan

- Delivered a talk on "Ocean Technology – The future", in an Interactive workshop on the marine environment its applications, and management, as part of Azaadi Ka Amrith Mahotsav, at Kanchi Mamunivar Government Institute of Postgraduate Studies and Research, Puducherry on October 23, 2021.
- Delivered a talk at Coimbatore Institute of Technology in the CIT-industry Alumni Conclave on March 14, 2022.

Mr. Biren Pattanaik

- 'Ocean Energy' in All India Radio (AIR), Berhampur, Odisha on April 2, 2021.

Mr. Prasad Dudhgaonkar

- "Ocean Energy Harvesting Technologies and Developmental Activities at NIOT", Indian Institute of Technology Roorkee on 12th October 2021.
- "Ocean Energy and Fresh Water – an overview of Ocean Energy Harvesting Technologies", ISA (Jamaica) - GoI MoES Training, February 10, 2022.

Dr. A. Ganesh Kumar

- Delivered lecture on "Exploration of novel bioactive metabolites from deep-sea piezophiles" in Department special lecture series organised by Department of Microbiology University of Madras, Chennai on March 5, 2022.

Dr. Pankaj Verma

- Delivered a talk during science and health workshop on the "Marine Biotechnology: Emerging Perspectives" at Sathyabama Institute of Science and Technology, Chennai, March 1, 2022.

Dr. Dilip Kumar Jha

- Delivered a lecture on "Marine Resources, Conservation, and Management" in National seminar on Frontiers In Marine Resources, Biotechnology & Conservation at Nirmala College For Women, (Autonomous), Coimbatore on April 17, 2021.

Mr. D. Narendrakumar

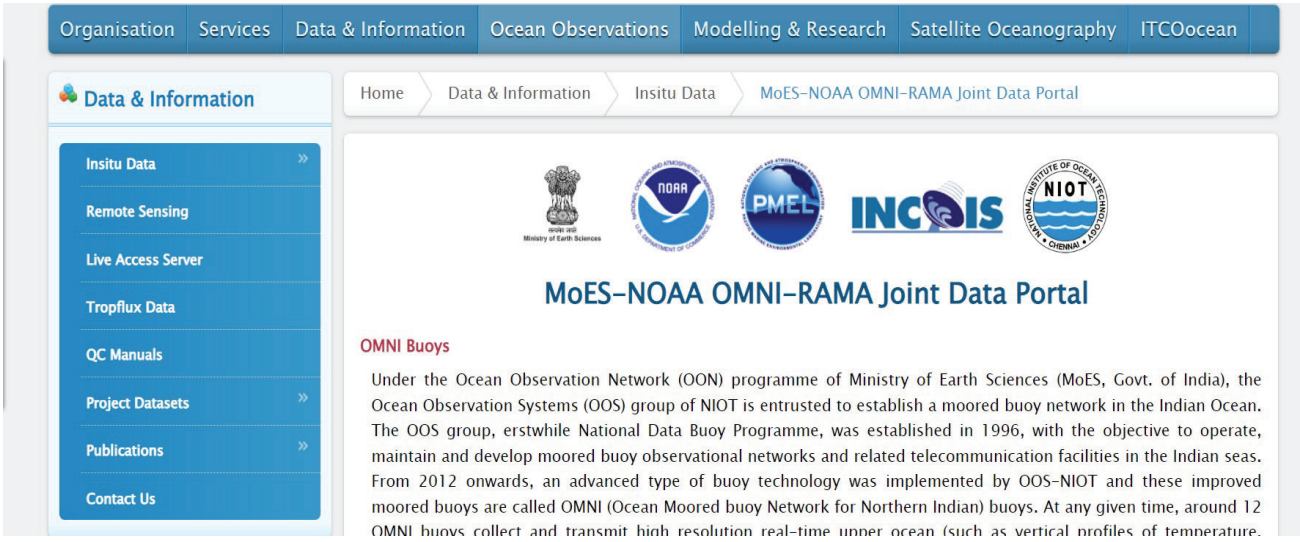
- Delivered a technical talk on "Best Practices of 'Swachh Bharat' Clean-up Initiatives onboard NIOT Ships" conducted by NIOT/MoES through virtual platform at NIOT, on July 12, 2021.

15. INTERNATIONAL COLLABORATION

- A Memorandum of Understanding (MoU) was signed between Krylov State Research Centre, Russia, and NIOT at the Ministry of Earth Sciences (MoES) for the development of a habitable capsule for manned submersible and mining systems.

- MoES- NOAA/PMEL Collaborative Programme - RAMA Buoy network: Under the MoES& NOAA MOU, OOS group of NIOT is entrusted to coordinate with NOAA- PMEL to maintain 25 moored buoys in Indian Ocean (Figure 8). Due to COVID-19 pandemic travel restrictions in USA, no cruises were undertaken during this period for RAMA buoy service.

- OMNI-RAMA Joint Portal : Following the second edition of India-US colloquium on Earth Observations and Sciences for Society and Economy held at NIO Goa, MoES and PMEL-NOAA has agreed to jointly open up a data portal for public access (Figure 9). The OMNI-RAMA joint data portal developed by NIOT-OOS & INCOIS in association with NOAA host data from 9 OMNI buoys deployed outside the EEZ in the Indian Ocean region along with metadata information and provide free access to the scientific community. Dr.Ashutosh Sharma, Secretary MoES launched the portal in the presence of Mr. Craig McLean, Assistant Administrator for Research and Acting Chief Scientist of NOAA on 09th August 2021. All moored buoy data outside the EEZ are being shared in this joint portal.



- Indian Arctic Mooring (IndARC) **:** Jointly with NCPOR, Indian arctic mooring-IndARC is being maintained in arctic waters since 2014.Data is collected and retrieved for more than five years. IndARC-V mooring was successfully retrieved with the support of Italian mooring team on 30 August 2021.

Recovery of IndARC mooring

- OceanSITES: The global ocean observational network, which aims to collect multidisciplinary data worldwide from the full depth water column. Two moored buoys, one in the Arabian Sea and the other in the Bay of Bengal are identified as OceanSITES programme with deep ocean observations by OOS. The moored buoy AD07in Arabian sea (15N,69E) was successfully augmented with additional CT sensors at 2000m, 3000m and 4000m.The Bay of Bengal deep ocean mooring is deployed at 13N/84E, with CT sensors at 1000m, 2000m and 3000m to collect deep ocean data.

- India is a member of Ocean Energy Systems (OES), a technological Collaboration Program (TCP) under the International Energy Agency (IEA),with NIOT being the nodal agency since 2016. NIOT has participated in the webinars for various taskgroups under OES. India has been jointly coordinating a subtask on OTEC and a white paper on OTEC was published by OES in October 2021 for policymakers and stakeholders.

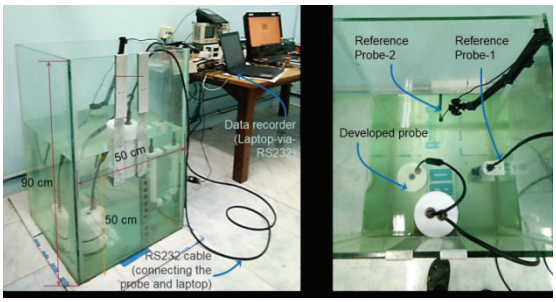
  Dr. Purnima Jalihal holds the position of Vice-Chair in the OES cabinet, the first Indian to do so.

16. NATIONAL COLLABORATION

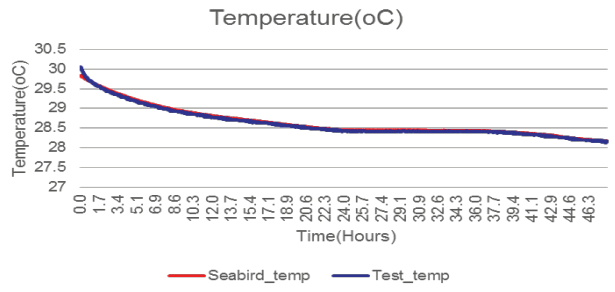
- Signed MoU with Bhabha Atomic Research Centre (BARC), Kalpakam for collaborative research in advance biofouling control on 28.7.21.
- Development of Conductivity Sensor : A joint development of noncontact type conductivity sensor with IIT Madras is initiated and laboratory model tested for basic functionality with simulated and with various salinity conditions. Fabrication of field deployable unit is in progress.

Progress Achieved

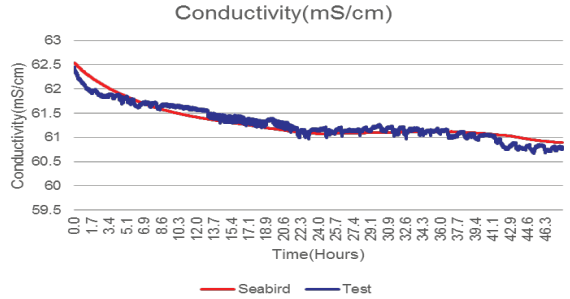
- ❖ Capacitive coupled contactless conductivity measurement technique evolved.
- ❖ 2 proto units developed and tested for lower and higher range of sea water salinity.
- ❖ Probe 2 design with combination of contact and noncontact electrode method is finalized. (Defined current path & NO external current flow).
- ❖ Field workable proto unit comprising two enclosures developed. (one for housing temperature & depth sensor and Electronics (PCBs) & next one to mount conductivity electrodes).
- ❖ Performance of proto unit compared with standard solution & Seabird Conductivity sensor at controlled laboratory environment.
- ❖ Applied for Patent.
- ❖ Tender initiated for the trial productions
- ❖ After user trial, technology transfer will be initiated.



Test set up – 48 hours



Temperature plot of 48 hrs test



Conductivity plot of 48 hrs test (RED-Seabird CTD & Blue – Proto unit)

Trial production of CTD is under progress and performance evaluation in comparison with similar devices will be carried out.

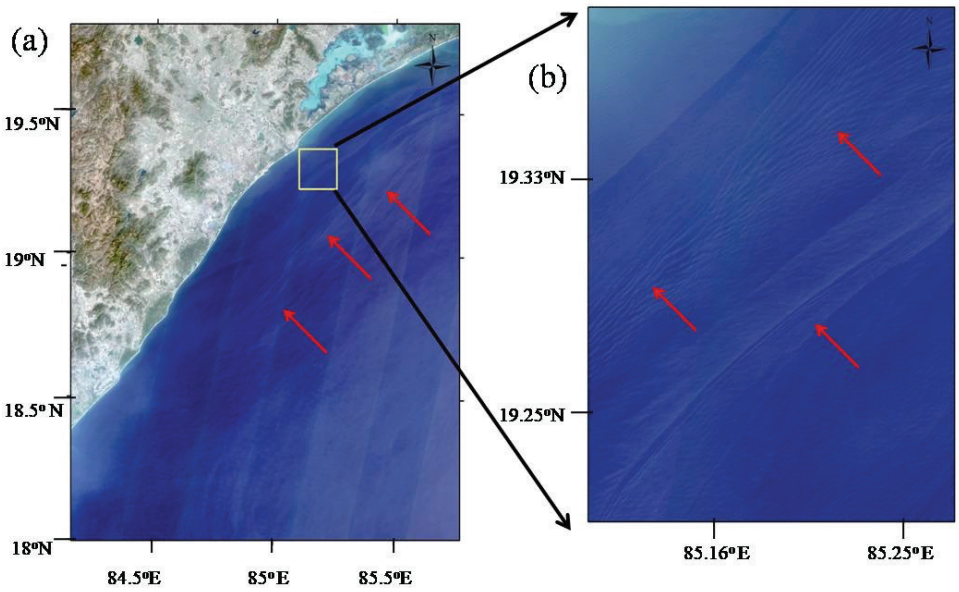
- **Collaborative work: SERB–VAJRA:** Visiting Advanced Joint Research Faculty Scheme (VAJRA)-Collaborative Research with Dr. Gopu Potty, University of Rhode island USA. He conducted a course on Inversion techniques through online from Feb 2021 to Sep 2021. Further he visited NIOT for a month during Dec 2021 and interacted with the Ocean Acoustics team. The team carried out geoacoustic inversion studies using real data provided by him from East China Sea as a case study. The implementation of the inversion algorithm was completed and presented as a paper in the conference OCEANS'22, Chennai. Currently inversion study using data from Bay of Bengal is in progress. Also enhancement of vector sensor array is discussed.

WBS	Cp_1 m/s	Cp_2 m/s	C_w m/s	C_{base} m/s	H m	d_1 m	d_2 m
34	1625 (12.5)	1580 (10.6)	1525 (3)	1685 (15)	106 (1)	2 (1)	17 (2)
39	1625 (12.5)	1592 (9.1)	1530.9 (3.2)	1659.1 (11)	109 (1)	2 (1)	12 (2)
43	1628 (11.25)	1579 (9.25)	1524.5 (4.1)	1645 (21)	107 (1)	2 (1)	16 (3)
48	1640 (7.75)	1589.5 (7.9)	1530.5 (3.6)	1658.4 (13)	105 (1)	2 (1)	15 (2)

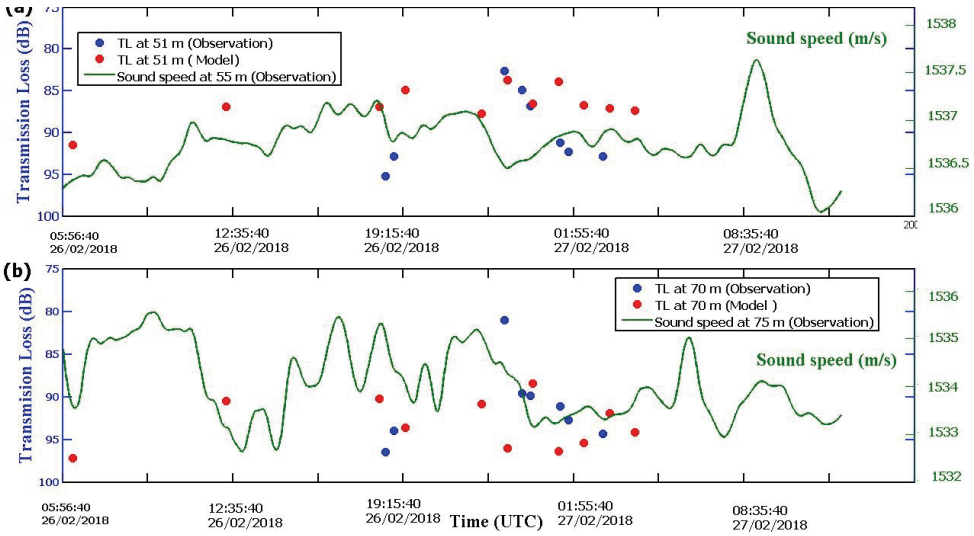
Summary of estimated parameters.

Internal Wave influence on Acoustic propagation in Northern Bay of Bengal

The study highlights influence of internal waves on sound propagation over a range dependent environment. Results of Transmission Loss (TL) were compared with field observation. Subsurface fluctuation has a strong influence on sound speed propagation at the location. The study identified features and variability in acoustic transmission using model and experiment. An open source model called WAVE adapted to shallow water environment was used to simulate internal wave induced sound speed environment. Acoustic environment was characterized with field measurements for sound propagation modeling. Frequencies of 0.026-0.5 cph and 0.51-5 cph produce the sound speed fluctuation in the environment. The 950 Hz signal from an anchored vessel was received by an array of hydrophones moored 50 km away, with a loss of ~80-95 dB with respect to the source position, receiver depth and sound speed variability. . Variability in TL for all cases of transmission reveals the influence of source position in the internal wave acoustic environment during sound propagation.



Surface imageries of oceanic internal waves in shallow waters of northwest BOB during experiment.



Temporal variability of observed and modeled transmission loss with respect to sound speed at 50 km range for depths (a) 51 m and (b) 70 m for 950 Hz source transmission.

➢ **OOS collaborated with several national institutes under different projects during this year.**

- OOS supported deployment of bio-geo sensor (Seabird 16 plus) for INCOIS in northern Arabian Sea mooring location.
- A program on "Marine Micro-plastics Study" has been initiated in collaboration with NCCR. Under this program, two cruises have been conducted to collect water/sediment/plankton samples in deep/coastal ocean for Micro-plastic study.

- Technical support extended to IGCAR for deployment of buoy system for monitoring Gamma radiation in Kalpakkam coastal waters.
- Department of Science Technology-SERB TARE project jointly with SRM university for development of optimal energy system for autonomous marine platform with micro grid solar photovoltaics.

➢ **Estimation of wave forces (breaking & non-breaking) through wave structures interaction studies.**

- Indian Institute of Technology Madras, Chennai

➢ **Feasibility studies on fixed and floating platform for offshore wind turbine**

- National Institute of Wind Energy, Ministry of New and Renewable Energy, Chennai.
- Indian Institute of Technology Madras, Chennai.

➢ **Collaborative project between IMU, TNSDA & NIOT:**

- A collaborative project with the Indian Maritime University [IMU], The Tamil Nadu State Department of Archaeology [TNSDA] & the National Institute of Ocean Technology [NIOT] titled **"Offshore Reconnaissance Survey of a Sangam Age Korkai Port"** is being taken-up by VMC-NIOT team. It is proposed to conduct a preliminary survey to identify a suitable location for deep-sea excavation at Korkai, a Sangam era port of the Pandya Kings using Sagar Tara/Sagar Anveshika.

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

- Member, School Board of Allied Studies, IMU, since March 2022.
- Member, Expert Committee to review 4th Tranche FTT-FTC Projects (2022-2024) under Ecology, Environment, Earth, Ocean Sciences and Water (E3OW) Theme, CSIR, since March 2022
- Member, Expert Panel on evaluation and review of proposals against DST WTI call 2021 on Desalination Technologies, since Nov 2021.
- Member, Project Monitoring Committee to Review the Mission Innovation sanctioned projects under IC3 (carbon capture) and IC5 (converting sunlight) calls.
- Member, Technical Unit for Technology Screening for Jal Jeevan Mission, Constituted by Principal Scientific Adviser, Govt. of India, since Feb 2020.
- Member of Executive Committee of Institute for Energy Studies, Anna University.

Dr. M.V. Ramana Murthy

- Member, Expert Appraisal Committee(Infra-1) for projects related to infrastructure development, industrial estate/parks/complexes/areas, export processing zones, special economic zones, biotech parks, leather complexes and national highway projects.
- Member, Expert Appraisal Committee (Infra-2) for projects related to all ship breaking yard including ship breaking unit, airports, common hazardous waste treatment, storage and disposal facilities, ports and harbours, aerial ropeways, CETPs, common municipal solid waste management facility, building/construction projects, townships and area development projects.

- Member, Expert Appraisal committee for the proposal involving violation of EIA notification.
- Member of finalization of Shoreline Management plan for Tamil Nadu committee.

Dr.R.Venkatesan

- On the nomination of MoES & IMD, the Permanent representative of India with UN body World Meteorological Organization (WMO), Dr R Venkatesan has been appointed as Vice Chair at a newly restructured WMO Study Group on Ocean Observations and Infrastructure Systems (SG OOIS).
- Steering Committee Member for Deep Ocean Observing Strategy (DOOS) Project of UNESCO IOC.
- Steering committee member Asia-Pacific GOOS UNESCO IOC nominated by Govt. of India.
- Data Buoy Cooperation Panel of UNESCO IOC & WMO Chair of International Tsunamters Partnership and in Vandalism of Ocean Platforms work group.
- National Consultant for SACEP-NORAD-International Maritime Organization by Govt, of India.
- Selected as National Contact Point in Belmont forum for Arctic Observing and Research for Sustainability.
- Member of Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM).

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, SRM University, Chennai
- Reviewer for International J.of Acoustic Soc. Am (USA)
- Recognized Reviewer for Journal, Measurements (Elsevier)
- Reviewer for SYMPOL International Conference, 2021
- Reviewer for Oceans, 2021 & 2022 IEEE International Conferences
- Co-ordinator from NIOT for the Indo-French co-operation.

Dr. D. Rajasekhar

- 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.
- 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. 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.
- Member, India Meteorological Society.
- Member, Ocean Society of India.

Dr.Tata Sudhakar

- Member in PMGC (Subcommittee) for Manned submersibles program.
- Member, Committee for finalizing the battery for Manned submersibles system.
- Member Board of Studies, Saveetha Engineering College.

Dr.Vijaya Ravichandran

- Member, Environmental Appraisal Committee for Nuclear, Defense and Strategic Projects in the Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India.
- Member, Hindi implementation and development committee, NIOT.
- Member, Committee for prevention of sexual harassment of women, National Institute of Wind energy.
- Member, Joint Committee constituted by National Green Tribunal for inspecting sea water quality along North Chennai coast.
- Member, Joint Committee constituted by National Green Tribunal for Appeal No . 14 (SZ) challenging the Environmental Clearance granted to fishing harbours at Azagankuppam and Alamparaikuppam in Tamil Nadu.
- Member, Joint Committee constituted by National Green Tribunal to ascertain the nature of damage caused and possible impact on environment w.r.t the furnace oil leakage due to pipe burst at M/s. Travancore Titanium Products Ltd, Kochuveli, Thiruvananthapuram.

Dr. Basanta Kumar Jena

- Bureau of Indian Standards (BIS) Member in Ports, Harbours and offshore Installations section committee, CED 47.
- Management Committee Member of International Association for Coastal Reservoir Research (ICARR) 2020-22.
- Members of WODA Working Group on Reservoir Dredging 2020-22.
- Data Buoy Co-Operational Panel Task Team Member DBCP.
- Member, Joint Review Committee constituted by MoEF&CC, IRO Gandhinagar, Water Front Development Project of M/s Adani Ports and SEZ Limited.
- Member, American Geophysical Union (AGU), since 2003, Florida Avenue N.W. Washington, DC 20009-1277 USA.
- Associate Member at ASCE, USA, American Society of Civil Engineers since 2003
- Member the Board of Governors of the Coasts, Ocean, Ports, and Rivers, Institute, USA, Since 2003.
- Life Member, Ocean Society of India, Since 2008.
- Secretary for Ocean Society of India (OSI), Chennai Chapter since 2020-22.
- Member, Coastal Education & Research Foundation, Inc. (CERF), official publisher of the Journal of Coastal Research (JCR), Society member since January 2012.
- Member for the Coastal protection committee CWC, CPDAC, New Delhi.
- Member for the CEE-47, BIS, New Delhi.
- Member in various conference committees: OSICON21, OCEAN-2022
- Member, 7th National Conference of the Ocean Society of India (OSICON21) 12-14 August 2021.

- LOC Member, OCEANS 2022, IEEE OES, February 2022 and Chairman for two technical sections.
- Member, IMS-OSI Joint session on Role of Ocean in Climate (ROC) in the INTROMET 2021
- Reviewer, Frontiers of Environmental Science & Engineering
- Doctoral Committee Member, IMU, Visakhapatnam.
- Doctoral Committee Member, IMU, Chennai.
- External Examiner, for conducting Ph. D Viva Voce examination.

Dr. S.V. S Phani Kumar

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

Dr.S.Ramesh

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

Cdr.Gopkumar Kuttikrishnan

- Fellow of Institution of Engineers (India) (Marine Engineering) and Member of Institute of Marine Engineers (India).

Dr. N. Vedachalam

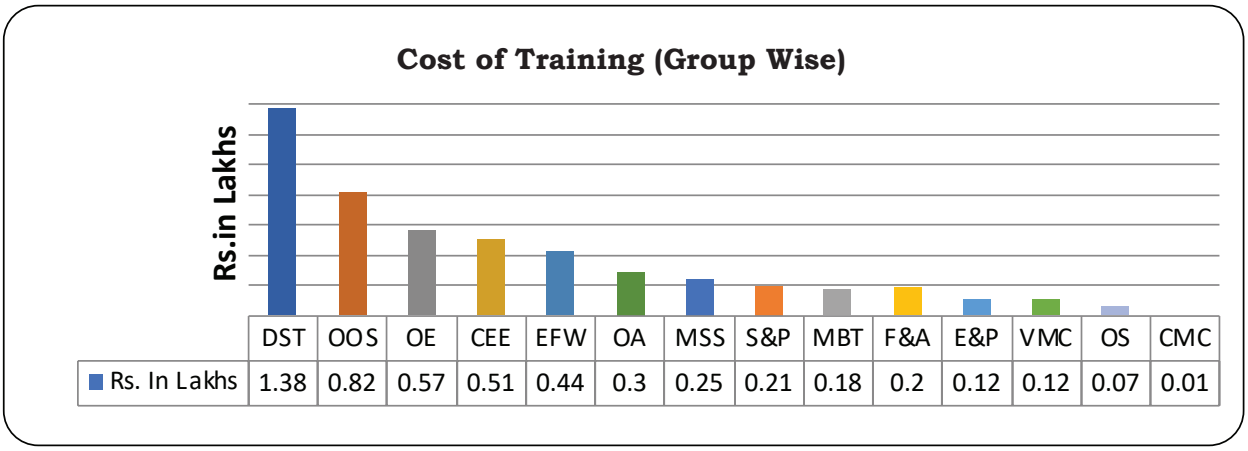
- Member, Marine Technology Society
- Member, Society for Underwater Technology
- Member, International Society of Offshore and Polar Engineers
- Member, IEEE OES
- Member, Naval Research Board

18. HUMAN RESOURCE DEVELOPMENT

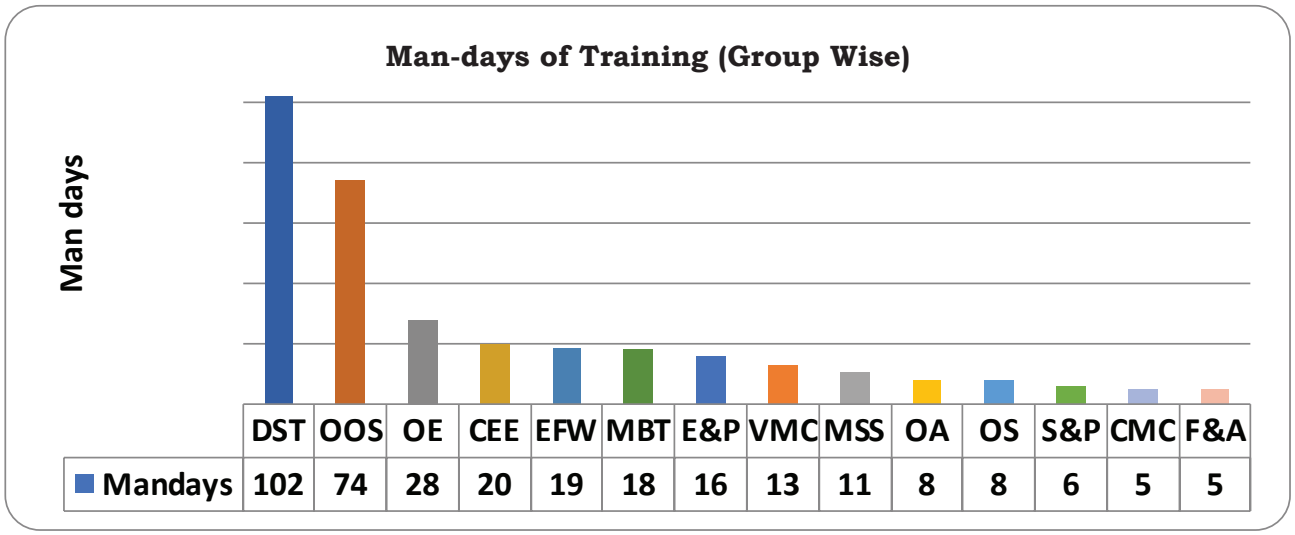
The section organizes training courses in the areas of engineering, software, project management, personality development, product trainings etc. Besides the external training courses, efforts are also made to conduct extra mural lectures by eminent personalities in other fields which are beneficial 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 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 21 students completed the project work in various departments of NIOT. About 55 students did their short term internships (minimum 2 weeks maximum 4 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.



	DST	OOS	OE	CEE	EFW	OA	MSS	S&P	MBT	F&A	E&P	VMC	OS	CMC
Rs. In Lakhs	1.38	0.82	0.57	0.51	0.44	0.3	0.25	0.21	0.18	0.2	0.12	0.12	0.07	0.01



	DST	OOS	OE	CEE	EFW	MBT	E&P	VMC	MSS	OA	OS	S&P	CMC	F&A
Mandays	102	74	28	20	19	18	16	13	11	8	8	6	5	5

Training Undergone by NIOT Scientists and Technical Staff			
S.No.	**Name of the Staff**	**Online Training/Conference/ Workshop Programme and Organized by**	**Period**
1.	Mrs. V. Bala Naga Jyothi Scientist - D	AI & ML organized by NIELET Taramani	6 weeks (30 hours) from 5th July 2021
2.	Mrs. G.V. Ahalya, Executive	Training on Tendering Process & Contract Management, NPC, Jaipur	15.07.2021 to 16.07.2021
3.	Mrs. S. Vasanthi Junior Executive		
4.	Mr. Sasikumar, Technician Grade -A		
5.	Mr. Kesavakumar, Scientist - D	IEEE MASCON, Chennai	27.08.2021 to 28.08.2021
6.	Ms. Rosmy Cheriyan, Scientist - B	Mike 21 Flow Model HD FM organized by DHI (India) Water & Environment Pvt Ltd, new Delhi	25.08.2021 to 27.08.2021
7.	Mr. Abhijeet Sajjan, Scientist - D	Corrosion of Reinforcement and its Control organized by CSIR-SERC	07.10.2021 to 08.10.2021
8.	Mr. Trishanu Shit, Scientist - D		
9.	Dr. S. Ramesh, Scientist - G	Training programme on Policy for Science and Science for Policies, organized by NIAS-DST, Bengaluru	25.10.2021 to 29.10.2021
10.	Dr. S.V.S. Phanikumar, Scientist - G		
11.	Mrs. K. R. Anuradha, Assistant Manager	Workshop on “Establishment Rules2 (ER-2-04), ISTM, New Delhi	22.11.2021 to 26.11.2021
12.	Mrs. J. Vatchala Kuppuraman, Senior Executive		
13.	Dr. Dilip Kumar Jha, Scientist - B	Capacity Building Program for Technical Personnel , Organized by AMITY - DST, NOIDA	06.12.2021 to 17.12.2021
14.	Mr. Rahul Bharti, Scientist - B		
15.	Mrs. K. Chithra, Scientist - E	SYMPOL Conference , CUSAT, Kochi	09.12.2021 to 11.12.2021
16.	Mrs. RathiKumari, Assistant Manager	Financial Modelling for strategic decision organized by Birla Global university, Bhubaneswar, Odisha	17.12.2021 to 18.12.2021
17.	Mrs. V. Bala Naga Jyothi, Scientist - E	Application of machine learning and Deep Learning in Data Science organized by NIT Warangal	28.02.2022 to 04.03.2022
18.	Mr. Doss Prakash, Scientist - D		
19.	Mr. K. Prabhakaran, Scientist - D		
20.	Mr. R. Sundar, Scientist - D		

Training Undergone by NIOT Scientists and Technical Staff			
S.No.	**Name of the Staff**	**Online Training/Conference/ Workshop Programme and Organized by**	**Period**
21	Ms. Sonitha, Junior Translation Officer	Parliamentary Questionnaires on Official Language, Organized by AVNL Institute of Learning, Avadi, Chennai	23.02.2022 to 24.02.2022
22	Ms. Neetu, Junior Translation Officer		
23	Dr. D. Rajasekhar, Scientist - G	Foundation course on finite Element Method organized by Virtual Experimental Learning Private Limited, Bangalore	28.02.2022 to 12.03.2022
24	Mrs. RathiKumari, Assistant Manager	E-Invoice organized by KSA Compliance Services Private Limited	22.03.2022
25	Mr. M. Vadivelu, Senior Executive		
26	Mrs. K. Vijayalakshmi, Junior Assistant		

Extra Mural Lectures Delivered by Eminent Personalities

- **Prof. B.V. Mudgal,** Professor & Director-Centre for Water Resources-Anna University, Chennai, delivered a lecture on **"Fluid Mechanics – Part I"** on 6th May 2021.

- **Prof. J.S. Mani,** Professor (Retd), Department of Ocean Engineering, IT Madras, delivered a **lecture** on **"Coastal Processes"** on 9th September 2021.

- **Dr. Sreenivasa Varma,** Medical Director, Balagangadhara Varma Medical Research Centre, delivered a lecture on **"Best Practices To Be Followed During Current Pandemic"** on 23rd September 2021.

- **Prof. B.V. Mudgal,** Professor & Director-Centre for Water Resources-Anna University, Chennai, delivered a lecture on **"Fluid Mechanics – Part II"** on 18th November 2021.

- **Dr. S.S.C. Shenoi,** Former Director –INCOIS, Hyderabad & NIOT, Chennai, delivered a lecture on **"Ocean Currents - Their Causes & Dynamics"** on 26th November 2021.

- **Dr. Gopu R Potty,** Associate Professor, Department of Ocean Engineering, University of Rhode Island USA delivered a lecture on **"Particle Motion Sensors for Underwater Acoustics"** on 5th January 2022.

- **Dr. S.S.C. Shenoi,** Former Director –INCOIS, Hyderabad & NIOT, Chennai, delivered a lecture on **"Currents In The Indian Ocean - Their Causes & Dynamics"** on 21st January 2022.

- **Dr. V. Sanil Kumar,** Chief Scientist & Head, Ocean Engineering Division, CSIR-National Institute of Oceanography (Council of Scientific & Industrial Research), delivered a webinar lecture on **"Waves in the near shore waters of India"** on 14th February 2022.

- **Dr. Ir P.V. Chandramohan,** Chief Technical Officer (CTO), Navayuga Engineering Company Ltd, Hyderabad, delivered a webinar lecture on **"Harbour Layout and Breakwaters"** on 16th March 2022.

- **Dr. K. Murali,** Professor and Head, Department of Ocean Engineering, IIT Madras, Chennai, delivered a Webinar lecture on **"Computational Hydrodynamics – A Review"** on 23rd March 2022.

19. ADMINISTRATION

Following are the details of the manpower position during the period from 01.04.2021 to 31.03.2022 at NIOT.

(a) Staff Strength: 31.3.2022

The details of sanctioned strength and no. of posts filled are furnished here under:

Sl.No.	Category	Sanctioned strength	Filled in	Vacant
1	Director	1	1	0
2	Scientific	(*) 93	(*) 90	3
3	Technical	70	68	2
4	Administrative	24	23	1
5	Official Lang. Hindi	3	2	1
6	Multi- Tasking Staff	6	6	0
		197	**190**	**7**

(*) Two scientists on loan basis - NCESS, Thiruvananthapuram.

(b) Appointments : NIL

(c) Direct Recruitments :

1	Shri Rahul Bharti (Mechanical) Sci-B	Direct recruitment	15/4/2021
2	Shri Ram Kumar J (Civil) Sci-C	Direct recruitment	30/4/2021
3	Shri Ramkumar Sorzumar (Civil) Sci-B	Direct recruitment	24/11/2021

(d) Promotions Under Modified Flexible Complementing Scheme :

Sl.No	Name	Post	With effect from
1	Shri K Gopkumar	Scientist – G	1/7/2021
2	Shri R Srinivasan	Scientist – F	20/7/2021
3	Dr D Sathiyanarayanan	Scientist – F	20/7/2021
4	Shri Biren Pattanaik	Scientist – E	1/7/2021
5	Shri Bolem Srinivas	Scientist – E	1/7/2021
6	Shri Abhijeet Sajjan	Scientist – D	1/7/2021
7	Dr N Vedachalam	Scientist – G	1/1/2022
8	Smt K Chithra	Scientist – F	1/1/2022
9	Smt V Bala Naga Jyothi	Scientist – E	1/1/2022
10	Shri Devender Gujjula	Scientist – E	1/1/2022
11	Shri D S Sreedev	Scientist – E	1/1/2022

(e) Upgradation:

Vide Officer Order No.MoES/25/27/2009-Estt(pt) dated 24th Feb., 2021 Ministry conveyed the up-gradation of the post of Director from Scientist-G (Level-14) to Scientist-H HAG Level. Ministry vide Office Order No.MoES/25/02/2009-Estt (pt) dated 18th Nov., 2021 conveyed the up-gradation of the Pay Level of Dr G A Ramadass, Director, NIOT stands upgraded to Scientist-H (Pay Level 15) with effect from 15.2.2021.

(f) Superannuation :

Sl.No	Name	Post	Date of superannuation
1	Dr S Rajaguru	Scientist-C	30.6.2021
2	Dr R Venkatesan	Scientist-G	31.3.2022

(g) Resignation:

Sl.No	Name	Post	Date of superannuation
1	Dr Shijo Zacharia	Scientific Officer-Grade II	17/8/2021 (Technical formality)
2	Shri Sulabh Srivastav	Hindi Typist	28/12/2021

h) 1. Deputation Abroad : NIL

2. Fellowship :

Dr.R.Venkatesan Scientist-G & Group Head OOS was deputed to University of Massachusetts, Dartmouth, USA to undergo the second segment of Fulbright Nehru Academic and Professional Excellence Fellowship during 1st September to 31st October 2021.

(i) Re-Designation : NIL

(j) Ph.D.:

Dr P Muthuvel, Ph.D. Electrical Engg.
Dr R Srinivasan, Ph.D. ECE
Dr N R Ramesh, Ph.D Mechanical Engg.
Dr R Suresh, Ph.D Civil Engg.
Dr (Smt) A Malarkodi, Ph D Instrumentation Engg.

(k) Demise:

Sl.No	Name	Post	Date of demise
1	Shri M Radhakrishnan	Scientific Officer – Grade – I	31.5.2021

(l) Summary of Audit Observation

Sl.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	2021	-	-	-	-

(m) Matters Relating to Persons with Disabilities

Sl.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 2021-2022	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	In projects implemented by NIOT, it 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 2021-2022 indicating policy decisions and the activities undertaken by the Ministry / Department for the benefits of persons with disabilities.	The Annual Report for the year 2021-22 is under draft version only and yet to be completed.

20. RIGHT TO INFORMATION

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

Right to Information Annual Return 2021 – 2022

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

Ministry of Earth Sciences

Year : 2021–2022 (April 2021 to March 2022)

Progress in 2021 – 2022						
	Opening Balance as on 01.04.2021	**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 replied**
Requests	5	18	28	0	0	48
First Appeals	0	0	3	0	0	2

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**
250	-	-

RTI Annual Return Information System (2021 - 2022)	
National Institute of Ocean Technology, Chennai **Ministry of Earth Sciences** (Please note that field prefixed with * are mandatory)	
* Organization Status Attached Office	Autonomous Body under Ministry of Earth Sciences, Government of India
* Name of Organization (upto 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. (if any)	044 – 6678 3335
Website address of Department / Organization (Please do not write 'http://')	www.niot.res.in

RTI Annual Return Information System (2021 – 2022)	
National Institute of Ocean Technology, Chennai **Ministry of Earth Sciences** (Please note that fields prefixed with * are mandatory)	
* 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 :.....
17/08/2022

INDEPENDENT AUDITOR'S REPORT

Report on the Audit of the Standalone Financial Statements for theFinancial year ended 31.03.2022

Opinion

We have audited the financial statements of NATIONAL INSTITUTE OF OCEAN TECHNOLOGY (NIOT) Chennai which comprise the Balance Sheet as on 31st March 2022 and the Income & Expenditure Account and 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 2022 and excess of incomeover expenditure 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.

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 and Income & Expenditure Account and Receipts and Payments Account dealt with by this report are in agreement with the Books of Account.

4. In our opinion, Balance Sheet and Income & Expenditure Account and Receipts and Payments Account 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 : 22015316APEABZ2119

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

BALANCE SHEET AS AT 31ST MARCH 2022

(Amount in Rupees)

LIABILITIES	**Schedule**	**31.03.2022**	**31.03.2021**
CAPITAL FUND	1	4,12,85,40,747	3,77,29,62,046
RESERVES AND SURPLUS	2	64,68,03,718	60,75,47,378
EARMARKED / SPONSORED PROJECT FUNDS	3	1,07,03,01,392	(18,25,86,111)
CURRENT LIABILITIES AND PROVISIONS	4	1,32,11,98,341	2,00,84,50,177
TOTAL		**7,16,68,44,198**	**6,20,63,73,490**
ASSETS			
FIXED ASSETS	5	4,16,80,19,745	3,75,55,64,784
INVESTMENTS - OTHERS	6	1,29,07,84,159	1,45,42,78,605
CURRENT ASSETS, LOANS, ADVANCES, ETC.	7	1,70,80,40,294	99,65,30,101
TOTAL		**7,16,68,44,198**	**6,20,63,73,490**
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 17, 2022
Place: Chennai 600 100

DIRECTOR

PARTNER
CA T.A.P.VARADAKUTTI
Memb No: 015316
UDIN: 22015316APEABZ2119

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2022

(Amount in Rupees)

INCOME	***Schedule***	**2021-22**	**2020-21**
Scientific and Technical Consultancy Services		9,92,61,729	52,11,93,703
Other receipt		2,75,000	22,79,457
Grants-in-aid - Core Grant	8	42,40,00,000	43,00,00,000
Transferred from Core Grant (equivalent to depreciation charged during the year)		3,35,81,612	2,41,01,763
Interest Earned	9	81,21,336	1,21,69,125
Other Income	10	52,52,333	25,62,090
TOTAL (A)		**57,04,92,010**	**99,23,06,138**
EXPENDITURE			
Expenditure on Scientific and Technical Consultancy Services		7,68,08,699	46,80,03,715
Establishment Expenses	11	41,43,44,596	29,15,78,406
Administrative Expenses	12	8,13,26,463	8,40,18,663
Depreciation on assets created out of Core Grants		3,35,81,612	2,41,01,763
TOTAL (B)		**60,60,61,370**	**86,77,02,548**
Excess of expenditure over income (A-B)		-3,55,69,360	12,46,03,591
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)		63,82,043	58,96,117
2.**Balance of Excess of income over expenses on Scientific and Technical Consultancy Services transferred to**		-	-
Corpus Fund		2,24,53,030	5,31,89,988
3. Other Receipts		2,75,000	22,79,457
4.Interest Earned on Scientific & Technical Consultancy Services		69,91,626	88,35,098
Balance being excess of Expenditure over Income transferred to Schedule 1a - Core Capital Fund		-7,16,71,059	5,44,02,931
		-3,55,69,360	**12,46,03,591**
Significant Accounting Policies	13		
Contingent Liabilities and Notes to Accounts	14		

For National Institute of Ocean Technology, Chennai

Date: August 17, 2022
Place: Chennai 600 100

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: 22015316APEABZ2119

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2022

(Amount in Rupees)

SCHEDULE 1 - CAPITAL FUND		31.03.22		31.03.21	
	BALANCE AS AT THE BEGINNING OF THE YEAR				
A	MoES Projects	3,47,69,48,094		3,43,57,63,494	
	Add: Additions during the year	85,05,82,750		44,00,14,635	
	Less: Provision for Depreciation	39,47,51,379	3,93,27,79,465	39,88,30,035	3,47,69,48,094
B	CORE CAPITAL FUND		19,57,61,281		29,60,13,952
	BALANCE AT THE YEAR END (A+B)		**4,12,85,40,747**		**3,77,29,62,046**

Schedule -1

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SUB-SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2022

(Amount in Rupees)

SUB-SCHEDULE -1A - CORE CAPITAL FUND		31.03.22	31.03.21
	Transferred from Capital Fund	29,60,13,952	26,57,12,784
	Add: Grant received during the year	50,00,000	-
	Add: Excess of Income over Expenditure	-	5,44,02,931
	Less: Excess of Expenditure over Income	7,16,71,059	-
	Less: Transferred to I&E A/C (Equivalent of depreciation claim during the year)	3,35,81,612	2,41,01,763
	BALANCE AT THE YEAR END (Transferred to Capital Fund)	**19,57,61,281**	**29,60,13,952**

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

Schedule -1A

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2022

(Amount in Rupees)

SCHEDULE 2 - RESERVES AND SURPLUS		31.03.22		31.03.21	
	Reserves created out of Technical / Consultancy Projects				
i.	**Corpus Fund**				
	As per last Balance sheet	57,01,87,380		45,91,63,247	
	Additions during the year	5,69,53,951		11,10,24,133	
	Deductions during the year	43,49,220	62,27,92,111	-	57,01,87,380
	Sub - Total		62,27,92,111		57,01,87,380
ii.	**Scientific & Technical Consultancy Project Equipment Fund**				
	As per last Balance sheet	3,73,59,998		3,03,11,366	
	Additions during the year	18,85,301		1,95,35,709	
	Less: Depreciation on the assets created	1,52,33,692	2,40,11,607	1,24,87,077	3,73,59,998
	Sub - Total		2,40,11,607		3,73,59,998
	GRAND TOTAL (i+ii)		**64,68,03,718**		**60,75,47,378**

Schedule -2

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2022

PROJECT FUNDS

Details / Grants pertaining to	Balance as on	Add: Receipts			Less: Expenditure					Balance as on
		Grants			Expenditure	Project	Project Advances	Interest, other receipts payable to MoES	Interest, other receipts & refund of unspent balance paid to MoES	
	1.4.2021	Received	Other Receipts	Interest Earned and received	Revenue	Equipment/WIP	Earlier Year Adjustments			31.03.22
(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	38,50,57,969	36,50,00,000	25,92,990	98,93,240	12,51,16,511	55,99,521	2,20,00,000	1,24,86,230	1,10,70,577	58,62,71,358
Ocean Observation Network - Moored Ocean Observation Network and HF Radar	1,59,42,849	17,78,00,000	85,147	32,08,692	10,48,03,117	-7,52,983	-	32,93,839	1,52,998	8,95,39,717
Ocean Non-Living Resources - Geoscientific Studies of Exclusive Economic Zone	-32,80,122	9,80,19,000	-	2,57,721	11,43,21,272	73,61,562	-	2,57,721	-	-2,69,43,956
Operation & Maintenance of Research Vessels	-78,56,29,745	1,55,91,88,000	79,15,647	14,48,585	80,41,08,392	2,24,94,033	-	56,87,105	79,98,897	-5,73,65,940
B.SCHEME -DEEP OCEAN MISSION (DOM)										
Development of Technologies for Deep Sea Mining and Manned Submersible, Underwater Vehicles and Underwater Robotics	15,14,70,292	1,01,88,65,000	36,232	35,58,685	5,72,26,976	59,47,20,206	19,88,23,141	35,94,917	83,66,200	31,11,98,769
Technological innovation for exploration and conservation of deep sea biodiversity	3,50,00,000	6,00,00,000	-	-	3,889	-	-	-	-	9,49,96,111
Energy and freshwater from the Ocean	1,28,48,133	6,00,00,000	968	18,89,995	1,22,05,272	40,120	-	18,90,963	-	6,06,02,741
Advanced marine station for Ocean Biology	-	75,00,000	-	-	6,53,351	-	-	-	-	68,46,649
C.SCHEME- COASTAL RESEARCH SCHEME										
Seawater Quality Monitoring	18,70,023	-	-	41,784	17,35,559	-	-	41,784	-	1,34,464
Marine litter and Microplastic Project	14,09,557	-	-	22,736	8,43,756	2,97,150	-	-	2,91,387	-
D.SCHEME - RESEARCH EDUCATION & TRANING OUTREACH										
Information Technology and E-Governance activities	17,57,790	-	-	48,447	-	-	-	48,447	-	17,57,790
Preparation of Eleven nos of Models	1,78,440	-	-	-	1,78,440	-	-	-	-	-
SUB-TOTAL - 1 (A TO D)	**-18,33,74,815**	**3,34,63,72,000**	**1,06,30,984**	**2,03,69,885**	**1,22,11,96,535**	**62,97,59,609**	**22,08,23,141**	**2,73,01,006**	**2,78,80,059**	**1,06,70,37,702**
2. OTHER GOVERNMENT GRANTS										
National Post- Doctoral Fellowship	5,37,607	51,07,888	-	74,374	29,25,552	-		-	2,58,186	25,36,131
Protection of beach from sea erosion at selected locations along the Coast of Odisha	1,68,942	4,00,000	-	7,087	50,660	-		-	-	5,25,369
"Digital Poompuhar" network project	82,156	45,30,877	-	2,190	44,00,000	-		-	13,033	2,02,190
SUB-TOTAL - 2	**7,88,705**	**1,00,38,765**	**-**	**83,651**	**73,76,212**	**-**		**-**	**2,71,219**	**32,63,690**
TOTAL-1+2	**-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**
PREVIOUS YEAR	**12,79,33,543**	**1,37,98,40,098**	**2,19,41,426**	**1,44,16,544**	**1,25,04,23,468**	**44,00,14,635**	**-**	**3,62,79,620**	**-**	**-18,25,86,111**

Schedule-3

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

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2022

(Amount in Rupees)

SCHEDULE 4 - CURRENT LIABILITIES & PROVISIONS	31.03.22		31.03.21	
A. STATUTORY LIABILITIES				
Tax Dues	72,68,060		1,22,83,334	
CPF Contribution	69,29,700		62,13,005	
NPS Contribution	22,45,670	1,64,43,430	13,62,720	1,98,59,059
B.OTHER CURRENT LIABILITIES				
Pay & Allowances for the month of March 2022	3,40,71,927		2,69,80,852	
Outstanding Liabilities	49,23,77,508		89,26,31,466	
Interest & Other Receipts Refundable to MoES	2,73,01,006		3,62,79,620	
Earnest Money & Retention money	13,41,11,153		14,79,56,855	
NPS Subscription & Contribution - Legacy	3,43,59,844		5,22,11,703	
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)	63,82,043	72,86,03,481	58,96,117	1,16,19,56,613
Project Advances *(Vide Sub-Schedule:B)*		57,61,51,430		82,66,34,505
TOTAL (A+B)		**1,32,11,98,341**		**2,00,84,50,177**

Schedule-4

T.A.P. VARADAKUTTI & CO. 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 2022

Details / Grants Pertaining to	Balance as on 1.4.2021	Add: Receipts			Less: Expenditure				Balance as on 31.03.22
		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	21,17,08,687	2,83,52,910	21,86,389	-	7,33,91,050	18,85,301	1,95,00,000	2,24,53,030	12,50,18,605
On Deposit : Installation of 1 lakh litres per day capacity Seawater Low Temperature Thermal Desalination Plants at Agatti, Androtti, Minicoy, Amini, Kiltan & Chetlat Islands	61,49,25,818	-	-	10,04,52,002	2,17,40,827	24,25,04,168	-	-	45,11,32,825
TOTAL - B	**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**
PREVIOUS YEAR	**98,85,70,576**	**14,88,85,809**	**91,61,723**	**3,35,03,224**	**11,56,71,853**	**18,45,09,986**	**-**	**5,33,04,988**	**82,66,34,505**

Sub-Schedule: B

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 2022

SCHEDULE 5 - FIXED ASSETS

(Amount in Rupees)

S.No	DESCRIPTION	GROSS BLOCK					DEPRECIATION				Provision for loss / Unserviceable Assets				NET BLOCK	
		Cost/Valuation as on 01.04.21	Additions during the year	Project Advances Earlier Year Adjustments	Deletions	Cost/Valuation as on 31.03.22	Upto 01.04.21	Additions during the year	Deletion during the year	Total upto 31.03.22	Upto 01.04.21	Additions during the year	Deletion during the year	Total upto 31.03.22	As on 31.03.22	As on 31.03.21
A.	**FIXED ASSETS created out of MoES Grants**															
1	**Lands-Freehold**															
	NIOT Campus, Pallikaranai	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 Nellore, Andhra Pradesh	12,19,81,248	2,28,95,811	-	-	14,48,77,059	-	-	-	-	-	-		-	14,48,77,059	12,19,81,248
2	**Buildings**	-		-		-	-	-		-	-	-		-	-	-
	Buildings & Infrastructure at NIOT Campus	55,17,21,153	-	-	-	55,17,21,153	39,07,51,686	2,64,02,006	-	41,71,53,692	-	-		-	13,45,67,461	16,09,69,467
	Buildings - Seafront Research Facility for NIOT @ Pamanji & Chittedu, Nellore District, Andhra Pradesh	-	11,38,53,782	-	-	11,38,53,782	-	56,92,689	-	56,92,689					10,81,61,093	-
	Building at ACOSTI, Port Blair	2,78,93,543	23,49,91,935	-	-	26,28,85,478	2,24,47,994	2,39,68,445	-	4,64,16,438	-	-		-	21,64,69,040	54,45,549
3	**Equipment**														-	-
	General Equipment	16,28,70,664	47,11,334	-	-	16,75,81,997	11,74,89,693	71,79,606	-	12,46,69,298	-	-		-	4,29,12,699	4,53,80,971
	Project Equipment under MoES Projects Grants	7,74,11,54,977	21,42,41,860	-	1,68,750	7,95,52,28,087	5,17,28,00,073	36,50,90,245	1,52,706	5,53,77,37,612	4,93,98,459	-	-	4,93,98,459	2,36,80,92,017	2,51,89,56,446
	TOTAL UNDER (A)	**8,64,47,18,482**	**59,06,94,722**	**-**	**1,68,750**	**9,23,52,44,453**	**5,70,34,89,445**	**42,83,32,990**	**1,52,706**	**6,13,16,69,729**	**4,93,98,459**	**-**	**-**	**4,93,98,459**	**3,05,41,76,265**	**2,89,18,30,578**
B	**Capital work in progress**	**63,47,23,959**	26,56,86,800	-	**33,94,45,355**	**56,09,65,404**	-	-	-	-	-	-		-	**56,09,65,404**	**63,47,23,959**
C	**Advances to Capital Projects**	**19,16,50,249**	**15,00,00,000**	**22,08,23,141**	**3,36,06,921**	**52,88,66,469**	-	-	-	-	-	-		-	**52,88,66,469**	**19,16,50,249**
D	**Fixed Assets created out of Scientific & Technical Consultancy Projects**															
1	Scientific & Technical Equipment	16,21,85,505	18,85,301	-	-	16,40,70,806	12,48,25,507	1,52,33,692	-	14,00,59,199	-	-		-	2,40,11,607	3,73,59,998
	GRAND TOTAL (A+B+C+D)	**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**
	PREVIOUS YEAR	**9,18,18,12,529**	**49,12,28,610**	-	**3,97,62,944**	**9,63,32,78,195**	**5,40,27,55,975**	**43,54,18,876**	**98,59,899**	**5,82,83,14,952**	**6,09,52,724**	-	**1,15,54,265**	**4,93,98,459**	**3,75,55,64,784**	**3,71,81,03,830**

Schedule-5

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2022

(Amount in Rupees)

SCHEDULE 6 - INVESTMENTS		31.03.22	31.03.21
(All the Investments are with Nationalised Banks in Short Term Deposits)			
a.	Funds received for rendering Scientific and Technical Consultancy Services	10,00,46,364	15,75,35,480
b.	Reserves Created out of Scientific & Technical Consultancy Services- Corpus Fund	60,32,43,681	57,41,34,842
c.	Deposits from other Agencies	58,74,94,114	72,26,08,283
	TOTAL	**1,29,07,84,159**	**1,45,42,78,605**

Schedule-6

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 2022

(Amount in Rupees)

SCHEDULE 7 - CURRENTS ASSETS, LOANS & ADVANCES	31.03.22	31.03.21
A. CURRENT ASSETS		
Balance with Banks in Savings Accounts	1,49,73,57,952	61,37,67,679
Bank Fixed Deposits (earmarked for Margin Money for LC Opened)	11,01,00,000	-
B. LOANS AND ADVANCES		
i Staff Advances		
Non-Interest bearing Advances to employees	8,10,100	14,89,366
Interest bearing Advances to employees	1,18,079	2,52,846
ii Advances and other amounts recoverable in cash or in kind for value to be received		
Recoverable from Revenue Authorities	3,39,44,039	3,28,38,836
Prepaid Expenses	1,07,04,441	1,11,86,070
Project Advances	28,05,48,602	28,05,48,602
Deduct: Adjustments relating to earlier years (vide note below)	-28,05,48,602	-
Advance Payment to Suppliers	1,16,87,286	45,12,209
Other Receivables	1,22,50,543	3,03,79,324
iii Interest accrued but not due	3,10,67,855	2,15,55,170
TOTAL	**1,70,80,40,294**	**99,65,30,101**

Note: Since Project Advances are to be treated as liability account towards government, the same has been grouped in Schedule- 3 - Earmarked / Sponsored Project funds & Schedule - 5 - Advances to Capital Projects

Schedule-7

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT AS ON 31ST MARCH 2022

(Amount in Rupees)

SCHEDULE 8 - GRANTS-IN-AID-CORE GRANT	2021-22		2020-21	
Grants-in-aid received from MoES - Manpower,Operational expenses and Maintenance of National Institute of Ocean Technology				
GIA - SALARY	32,10,00,000		32,00,00,000	
GIA - GENERAL	10,30,00,000		11,00,00,000	
GIA - CAPITAL	50,00,000	42,90,00,000	-	43,00,00,000
Less: Amount allocated for Capital Expenditure and transferred to Capital Fund				
General Equipment		50,00,000		-
TOTAL		**42,40,00,000**		**43,00,00,000**

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 2022

(Amount in Rupees)

SCHEDULE 9 - INTEREST EARNED	2021-22	2020-21
On Savings Account	11,29,710	33,34,027
Interest Earned on Scientific & Technical Consultancy Services	69,91,626	88,35,098
TOTAL	**81,21,336**	**1,21,69,125**

(Amount in Rupees)

SCHEDULE 10 - OTHER INCOME	2021-22	2020-21
Rent Received	2,90,162	2,11,240
Sundry Receipts	49,62,171	23,50,850
TOTAL	**52,52,333**	**25,62,090**

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

Schedule-9&10

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
SCHEDULES FORMING PART OF INCOME AND EXPENDITURE ACCOUNT AS ON 31ST MARCH 2022

(Amount in Rupees)

SCHEDULE 11 - ESTABLISHMENT EXPENSES	2021-22	2020-21
Pay & Allowances	36,88,10,885	25,15,12,212
CPF Contribution	69,29,700	62,13,005
NPS Contribution	3,03,88,739	1,74,55,945
Medical Reimbursements	13,07,330	28,15,844
Children's Education Allowance	50,14,800	48,28,050
Leave Travel Concession	18,93,142	87,53,350
TOTAL	**41,43,44,596**	**29,15,78,406**

SCHEDULE 12- ADMINISTRATIVE EXPENSES	2021-22	2020-21
Computer Maintenance/LAN/Software / Maintenance of Plant & Machinery	1,31,59,486	1,81,53,710
Electricity & Water Charges	1,63,07,532	1,44,06,741
Campus Maintenance Expenses	3,47,42,920	3,78,47,083
Vehicles Running and Maintenance	8,26,687	8,87,923
Conveyance Expenses	3,29,539	4,62,833
Travel Expenses	3,58,416	2,22,806
Subscriptions to Journals & Bulletins	16,79,226	33,98,555
Expenses on Seminars & Workshops	28,15,227	16,524
Communication Expenses	22,26,912	22,65,061
Printing and Stationery	11,17,817	6,75,410
Advertisement & Publicity	3,30,006	1,58,282
Rent, Rates and Taxes	33,23,881	17,88,521
Hospitality Expenses	5,64,636	3,58,687
Professional charges	7,92,358	13,48,281
Auditor's Remuneration	82,600	76,700
Other Administrative Expenses	26,69,220	19,51,547
TOTAL	**8,13,26,463**	**8,40,18,663**

Schedule-11 & 12

राष्ट्रीय समुद्र प्रौद्योगिकी संस्थान NIOT National Institute of Ocean Technology

T.A.P. VARADAKUTTY & CHENNAI 600 083 Chartered Accountants

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI
RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2022

(Amount in Rupees)

RECEIPTS	2021-22	2020-21	PAYMENTS	2021-22	2020-21
I. Opening Bank Balances	61,37,67,679	70,10,64,258	**I. Expenses- Assistance to Autonomous Bodies**		
			a) Establishment Expenses	31,16,11,980	27,68,94,113
			b) Administrative Expenses	7,43,31,282	7,65,18,457
II. Grants Received			**II. Payments made against funds for various projects**		
a) Assistance to Autonomous Bodies	42,90,00,000	43,00,00,000			
b) MoES Project Grants	3,34,63,72,000	1,37,03,75,000	a) MoES Project Grants	74,03,47,807	66,95,84,811
c) Sponsored Project Grants from other sources	1,00,38,765	94,65,098	b) Sponsored Projects Payments from other sources	24,31,218	39,05,120
d) Deposit from other agencies	7,19,24,791	-	c) Deposit from other agencies	2,53,92,581	3,22,79,769
III. Scientific & Technical Consultancy Services - RECEIPTS	4,38,79,358	13,71,51,534	**III. Scientific & Technical Consultancy Services - PAYMENTS**	6,18,42,554	13,55,38,355
IV. Deposits Matured	1,40,57,25,019	74,19,96,670	**IV. Deposits Made**	1,23,25,92,455	32,68,39,174
			V. Purchase of Fixed Assets/WIP	66,00,33,026	57,99,29,557
V. Interest Received	3,70,36,738	2,37,20,116	**VI. Interest/Other Income remitted to MoES**	4,21,75,737	4,79,03,957
VI. NPS Subscriprtion & Contribution Received	5,19,27,257	3,50,91,273	**VII. NPS Subscriprtion & Contribution deposited to NSDL**	6,98,75,899	3,34,59,115
VII. Other Incomes	1,02,35,096	1,73,89,772	**VIII. Other Payments**	1,37,09,86,632	73,46,07,104
VIII. Any Other Receipts	6,90,72,420	6,49,73,489	**IX. Closing Bank Balances**	1,49,73,57,952	61,37,67,679
TOTAL	**6,08,89,79,123**	**3,53,12,27,211**	**TOTAL**	**6,08,89,79,123**	**3,53,12,27,211**

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 17, 2022
Place: Chennai 600 100

DIRECTOR

Partner
CA T.A.P.VARADAKUTTI
M. No: 015316
UDIN: 22015316APEABZ2119

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 Tamilnadu 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 15th June 2010 recognized National Institute of Ocean Technology, Chennai as a Scientific and Industrial Research Organization and accorded renewal of recognition vide their letter No.11/358/1998-TU-V dated 18th March 2019 from 1st April 2019 to 31st March 2022.

(v) Based on the renewal of registration, accorded by the Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India vide their letter No.11/358/98-TU-V dated 18th March, 2019 for the period upto 31st March 2022. The Institute is availing Concessional Customs Duty of 5.5% in terms of Government

Notifications No.51/96-Customs dated 23rd July 1996 and subsequent amendments as well as Concessional GST of 5% vide Notification No.47/2017 –Integrated Tax (Rate) dated 14.11.2017; No.45/2017-Central Tax (Rate) dated 14.11.2017; No.09-10/2018 - Union Territory Tax (Rate) & Integrated Tax (Rate) dated 14.11.2017 & G.O. (Ms) No.161 dated 14.11.2017 and subsequent amendments.

(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.

(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 account, only when the rendering of service under a contract is completed or substantially completed.

(iii) In respect of 'Core Grants-Capital' received from MoES, income is recognized in Income and Expenditure Account equivalent to depreciation charged on the assets and debited in the Income and Expenditure account 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 O-SMART & Deep Ocean Mission Scheme 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 Income & Expenditure Account 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 gain or loss adjusted to the contracts covered under MoES Projects and Scientific & Technical Consultancy Projects for the current year is Rs.3,22,288/- (Previous Financial Year 2020-21: Rs.6,76,409/-)

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 PFRDA.

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 Income &Expenditure Account 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: 22015316APEABZ2119

Date: August 17, 2022
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 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.

Further, 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. 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, for the amount of Rs.47.31 Crores, a sum of only Rs.32.00 Crores has been paid as per the demand/s made by VSSC till 31/03/2022. The balance sum of Rs.15.31 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 31.03.2022 in respect of the regular employees (188 Nos.) of NIOT is furnished below:-

Policy No	Scheme	Liability as per Actuarial Valuation along with service cost as on 31.03.22	Funds available with LIC in Policy Account as on 31.03.22	Balance Payable towards accrued liability as on 31.03.22
		(A)	**(B)**	**(A-B)**
				(in Rupees)
605009094	Group Leave Encashment	17,87,76,210/-	12,95,21,535/-	4,92,54,675/-
605009095	Group Gratuity	12,73,73,243/-	11,28,35,466/-	1,45,37,777/-
		30,61,49,453/-	**24,23,57,001/-**	**6,37,92,452/-**
Payable to LIC as on 31/03/2022 (for which provision have been made in the Books of Accounts)				**6,37,92,452/-**

3. Status of Insurance Claims

Total estimated claim of Rs. 20.65 Crores to be settled by Insurance companies as on 31.03.2021. Further a new claim of Rs. 0.44 Crores has been lodged during the year. As on 31.03.2022, the total claim of Rs.21.09 Crores have 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 2021-22, NIOT received total amount of Rs.334,63,72,000/- (Previous Financial Year 2020-21: Rs.137,03,75,000/-) as Grants-in-aid for various projects under the Scheme.

b. Capital Advances appearing in Schedule-5 of Balance Sheet comprising of (i)Advance for Land Acquisition for Sea Front Facility at Nellore, Andhra Pradesh Rs.3,45,29,134/- (being unspent balance as per the District Collector office letter dated 22.06.2022) and (ii) Advances to CPWD Infrastructure of Rs.12,35,14,194/- (iii) Advances to Vikram Sarabhai Space Centre (VSSC), of Rs.32,00,00,000/- (iv) Advance to other institutions of Rs.5,08,23,141/-

c. Interest/Other incomes of Rs.3,36,83,049/-(appearing in Schedule-4: Other Current Liabilities) earned and accrued during the year is refundable to the MoES.

5. Grants in Aid – Core Grant

NIOT received the Core Grant of Rs.42,90,00,000/- during the financial year 2021-22 (Previous Financial Year 2020-21:Rs.43,00,00,000/-) 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.

6. Accounting for Depreciation of Rs.44,35,66,682/- in the Fixed Assets Schedule.

a. Depreciation Rs.3,35,81,612/- 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.39,47,51,379/- is charged against Capital Fund on Assets created out of Scheme 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.1,52,33,692/- 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.

7. Interest Earned

During the financial year 2021-22, the Interest and Other Receipts under the MoES Projects for the Scheme, O-SMART & DEEP OCEAN MISSION Rs.2,73,01,006/- and Core Grant Rs.63,82,043/- totally amounting to Rs.3,36,83,049/- (Actual Interest Received/Other Income is Rs.3,16,06,682/- and Interest Accrued is Rs.20,76,367/-). Since this amount of Rs.3,36,83,049/- is refundable to MoES, the same is shown under the head 'Other Current Liabilities – Interest and other receipts refundable to MoES'.

8. Projects and Utilisation Certificates

The Project Review Board reviews the progress of the various projects periodically, including the financial budgets.

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 renders 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 in 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.

9. The total turnover/ gross receipts declared for Scientific & Technical Consultancy Services as per GST Returns filed for FY 2021-22 Rs.3,05,39,300/- is as per the tax invoices raised by NIOT on the clients during the year, whereas Scientific and Technical consultancy services as per Income and expenditure statement is Rs. 9,92,61,729/- 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.

10. Expenditure on Scientific & Technical Consultancy Services comprises of Revenue Expenses of Rs.7,49,87,972/- and capital expenses of Rs.18,20,727/- in the Income & Expenditure account is the total expenses incurred in respect of the consultancy services projects completed during the year

11. **Taxation**
Since NIOT is registered under section 12AA of the Income Tax Act, 1961 and in view of there being no taxable income under Income Tax Act, 1961; no provision for Income tax has been considered necessary.

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

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

14. Schedules 1 to 14 are annexed to and forms an integral part of the Balance Sheet as at 31st March 2022, Income and Expenditure Account and Receipts and Payments account 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:22015316APEABZ2119

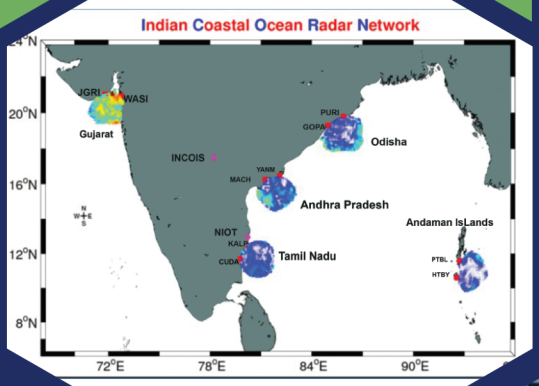
Date: August 17, 2022
Place: Chennai 600 100

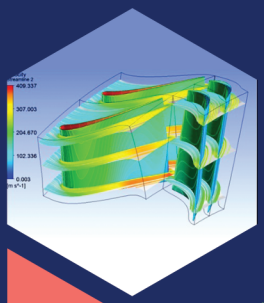
An international webinar on “OTEC – Some Developments and Way Forward” was organised by NIOT under the aegis of OES-TCP on 29th March 2022 with keynote speakers from USA, Japan, South Korea, Malaysia, Indonesia and Netherlands.

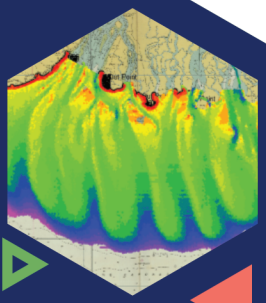
The International Women’s Day was celebrated by NIOT on March 8, 2022. Smt.Indira Murthy, Joint Secretary, MoES graced the occasion as the Chief Guest and delivered the Women’s day Special address. Dr.G.A. Ramadass, Director NIOT and. Dr.R. Krishnan, Director IITM Pune gave Women’s day remarks.

NIOT celebrates Hindi fortnight every year to promote the Official Language. During the year 2021-22, it was celebrated with enthusiasm on the Hindi Diwas i.e.14.09.2021. As part of this event, many competitions were conducted for the staff and prizes were given to the winners.

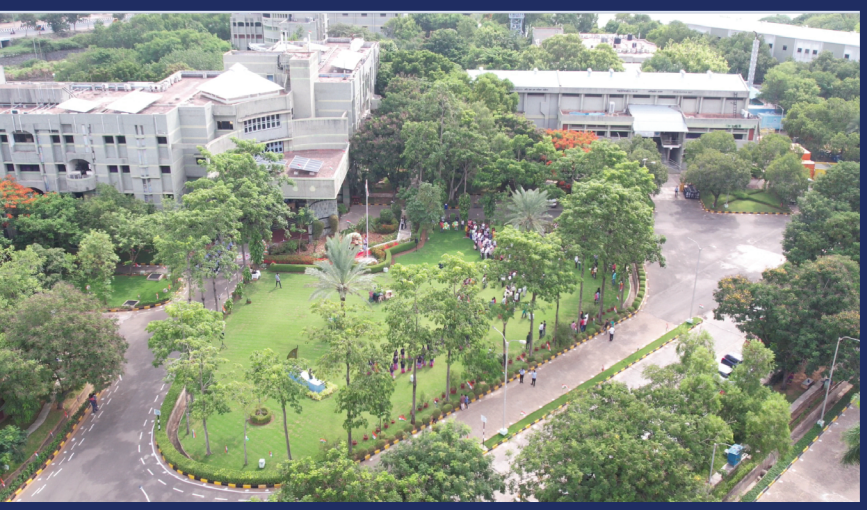
Swachhata Pakhwada Celebrations at NIOT were held during July 1-15, 2021. Cleanliness campaign inside the NIOT campuses at Chennai, Atal Centre for Ocean Science and Technology in Islands (ACOSTI), Port Blair and Seafront Facility at Nellore was conducted. The staff participation in the cleaning activities at Minnie Bay, Port Blair is shown.







Human acclimatization test on sphere



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