

## INSTITUTE AT A GLANCE

### Organization

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, Ministry of Earth Sciences and the Director is the head of the Institute.

The major aim of setting up NIOT under the Ministry of Earth Sciences is to develop reliable indigenous technology to solve the various engineering problems associated with harvesting of non-living and living resources in the Oceans.

### Mission Statement

- To develop world class technologies and their applications for sustainable utilization of ocean resources.
- To provide competitive and value added technical services in the field of ocean science and technology.
- To develop a knowledge base and institutional capabilities in India for management of ocean resources and environment.

## MEMBERS OF THE GOVERNING COUNCIL AND THE GENERAL BODY OF NIOT FOR THE YEAR 2015-16

Sl. No.	Name	Designation
1.	<b>Dr. Shailesh Nayak</b> Secretary to Govt. of India Ministry of Earth Sciences, New Delhi	Chairman From 27 <sup>th</sup> August 2008 To 31 <sup>st</sup> August 2015
	<b>Prof. K. Vijay Raghavan</b> Secretary to Govt. of India Ministry of Earth Sciences, New Delhi	From 1 <sup>st</sup> September 2015 To 6 <sup>th</sup> December 2015
	<b>Dr. M. Rajeevan</b> Secretary to Govt. of India Ministry of Earth Sciences, New Delhi	From 7 <sup>th</sup> December 2015
2.	<b>Smt. Anuradha Mitra, IDAS</b> Joint Secretary & Financial Advisor Ministry of Earth Sciences, New Delhi	Member From 17 <sup>th</sup> December 2014
3.	<b>Shri. B.N. Satpathy</b> Sr. Adviser (S&T), Planning Commission, New Delhi	Member From 14 <sup>th</sup> February 2013 To 31 <sup>st</sup> July 2015
	<b>Dr. C. Muralikrishna Kumar</b> Sr. Adviser (CIT&I and S&T) NITI Aayog, New Delhi	Member From 1 <sup>st</sup> August 2015
4.	<b>Shri U.V. Lakhane</b> Executive Director (Projects), Engineers India Limited, New Delhi	Member From 27 <sup>th</sup> February 2012
5.	<b>Dr. P.S. Nair</b> Former Dy. Director, ISAC, Bangalore	Member From 6 <sup>th</sup> June 2006
6.	<b>Shri. Anand Singh Khati, IRPS</b> Joint Secretary (Admin), Ministry of Earth Sciences, New Delhi	Member From 30 <sup>th</sup> July 2012
7.	<b>Shri. D.K. Das</b> Deputy Director, Space Application Centre, Gujarat	Member From 10 <sup>th</sup> March 2015
8.	<b>Prof. Bhaskar Ramamurthi</b> Director, Indian Institute of Technology Madras, Chennai	Member From 27 <sup>th</sup> February 2012
9.	<b>Shri. Kedarnath Shenoi</b> Director, Naval Physical & Oceanographic Lab, Kochi	Member From 1 <sup>st</sup> March 2015
10.	<b>Dr. C. Durga Malleswar</b> Director, Naval Science & Technological Lab, Visakhapatnam	Member From 1 <sup>st</sup> October 2013
11.	<b>Dr. Swati Basu</b> Advisor, Ministry of Earth Sciences, New Delhi	Permanent Invitee From 1 <sup>st</sup> Jan 2015 To 31 <sup>st</sup> Dec 2015
	<b>Dr. M.P. Wakdikar</b> Advisor, Ministry of Earth Sciences, New Delhi	Permanent Invitee From 1 <sup>st</sup> January 2015
12.	<b>Dr. A.B. Mandal</b> Director, Structural Engineering Research Centre, Chennai	Permanent Invitee From 1 <sup>st</sup> Dec 2014 To 30 <sup>th</sup> April 2015
	<b>Shri Shyam Chetty</b> Director, Structural Engineering Research Centre, Chennai	Permanent Invitee From 1 <sup>st</sup> May 2015 To 29 <sup>th</sup> Dec 2015
	<b>Prof. Santosh Kapuria</b> Director, Structural Engineering Research Centre, Chennai	Permanent Invitee From 30 <sup>th</sup> December 2015
13.	<b>Dr. M.A. Atmanand</b> Director, NIOT	Member Secretary From 21 <sup>st</sup> Oct 2009 To 30 <sup>th</sup> July 2015
	<b>Dr. S.S.C. Shenoi</b> Director, NIOT	Member Secretary From 1 <sup>st</sup> August 2015



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## FROM THE DIRECTOR'S DESK

I am delighted to present you the Annual Report of NIOT for the year 2015-2016. I am pleased to see the really fascinating and excellent work being done by a relatively modest number of people with a modest budget. Advancement in expertise through capacity building in ocean technology over the past two decades has been matured enough to deliver on



countries demands. Institute has succeeded in showcasing some of the key technologies for the benefit of the society in the form of forecast systems and harnessing ocean resources. The untiring efforts of NIOT personnel in conceptualization, engineering design, system realization, successful testing in the field and application in societal programmes has brought laurels to the institute.

The persistent efforts of Ocean Energy team of NIOT helped India in becoming the member of International Energy Agency – Ocean energy Systems. Government of India appointed NIOT to serve as the nodal agency to accelerate the research in the areas of ocean energy in the country. The team has developed a proto-type current turbine with indigenous design and successfully demonstrated the same in the Andaman Sea. Overall energy conversion efficiency was improved for Backward Bent Ducted Buoy (BBDB) and tested at sea with optimized turbine design to generate power from the waves.

Indigenously developed 500 m depth rated shallow water / polar remotely operated vehicle (PROVe) was successfully deployed by the Deep Sea Technology group, in the Andaman coral Islands and the vehicle was successfully maneuvered in the undulating reef terrain to record high quality underwater visuals of coral reef biodiversity with spectral irradiance. In order to harvest the non-renewable resources, the group has completed the configuration study for the polymetallic nodule mining system and successfully finalized the vertically hanging Flexible Riser System. Further, the group demonstrated the deep sea autonomous coring system that can land on soft sea floor of low bearing strength soil of Krishna Godavari basin gas hydrate site at a depth of 1057 m. A soft foot assembly was specially designed to facilitate its landing on soft soil. The autonomous coring system succeeded in subsea drilling upto 40 m below sea floor.



Expertise in establishing ocean observation systems has been demonstrated to the world community through the successful data collection from the IndARC moored observatory in the Kongsfjorden region of Arctic. The mooring was retrieved in July 2015, after a year, with additional sensors for ocean acoustics. A prototype Indian Tsunami Buoy System (ITBS) - 'Sagar Bhoomi' also was developed and successfully tested in the Bay of Bengal at a water depth of 3320m. The Sagar Bhoomi deployed in Oct 2015 worked successfully till it was retrieved in Feb 2016.

The Ocean Acoustics programme attained another feat by incorporating Ambient Noise Measurement System in the IndARC mooring in Arctic. Preliminary measurements of passive acoustics revealed the noise of ice-cracking. The team participated in the International Indian Ocean Expedition (IIOE-2) onboard ORV Sagar Nidhi, during December 2015, and measured the ambient noise in the deep waters. A three element vector sensor array for a frequency range of 100 Hz to 6 kHz was developed and tested successfully in the Underwater Acoustic Research Facility (UARF) in Idukki and in the fishing harbor in Chennai.

The Ocean electronics group transferred the Drifting buoy technology with INSAT communication system to Indian Industry for commercialization. The field trial of the Autonomous Underwater Profiling Drifter (AUPD) floats developed with industrial partner was successful in the field trial with depth rating up to 1950 m.

Reliability and repeatability are the important factors of Buried Object Scanning/detection Sonar (BOSS) indigenously developed by the Marine Sensor Systems team.

Ocean structures group has carried out the studies on wave structure interactions necessary before the field installations by making wave pressure measurements on the intake caisson and through prototype experiments. The group also designed a monopile for offshore wind turbine mast at Jakhau and off Pipavav for M/s. Suzolon and National Institute of Wind Energy (NIWE) Chennai after undertaking geotechnical investigations. The mast is being installed. An engineering solution was also worked out to protect the Pulicat lake ecology by increasing the water flow without affecting the environment. The work was carried out on the request of SHAR-ISRO.

The Coastal and Environmental Engineering group designed the shore protection measures for Kadalur Periyakuppam and Visakhapatnam coasts. A submerged geo-synthetic dyke has been constructed at Kadalur Periyakuppam to dissipate the wave energy before reaching the coast. Assessment of faunal assemblage on the artificial submerged reef of geo-synthetic material was also conducted to understand its impact on ecology.



Operational team onboard Sagar Manjusha rescued a fishing vessel Kesavan with 12 fishermen that was sinking off Nagapattinam. The team received the Search and Rescue (SAR) award 2015 from Indian Coast Guard/Ministry of Defense for the commendable act.

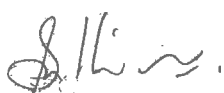
Marine biotechnology group has successfully developed the technology for production of extracellular glutaminase-free anticancer novel compound L-asparaginase from marine actinobacteria *Nocardiopsis alba*. Electro-flocculation techniques for harvesting of marine microalgae was developed and patented.

The program like cage culture, ocean energy and shore protection measures are already benefiting the society at large and it is our endeavor to develop the critical technology needed to provide the expertise in strategically important areas of deep sea technologies, ocean acoustics, transducer development, underwater vehicles, equipments for oceanographic measurements, coastal engineering etc.

During December 2015, NIOT got marooned due to the flooding that affected the Chennai city. The floods damaged some of the critical installations including the electric supply and DG sets. It is inspiring to note that the colleagues at NIOT restored the activities to normalcy within shortest possible time.

The continuous support and guidance received from the Governing Council under the chairmanship of Dr. Shailesh Nayak and later under the chairmanship of Dr. M. Rajeevan are greatly acknowledged. I thank Dr. Nayak and Dr. Rajeevan for the continued support and guidance in conducting the activities of NIOT. My thanks to the members of Governing Council for all their support and guidance. I also would like to thank the Chairs and members of Financial Committee and Scientific Advisory Committee for their help and advices in conducting the affairs of NIOT. My colleagues in Ministry of Earth Sciences and at the INCOIS, NCAOR, IITM, NCESS, NCMRWF, IMD, CMLRE, and ICMAM were always there with generous support for any issue that we wanted to solve. I thank them all.

I would like say a heartfelt thank you to NIOT members of staff for wholeheartedly cooperating and contributing to the progress of NIOT. Together, we have made significant progress and I hope NIOT continues to develop well in future. It is a proud moment for all of us.



**(SATHEESH SHENOI)**

## MAJOR ACCOMPLISHMENTS OF THE YEAR 2015-16

- India became a member of International Energy Agency – Ocean Energy Systems and nodal agency for the membership is National Institute of Ocean Technology.
- Sea trial was completed successfully for wave energy device Backward Bent Ducted Buoy (BBDB) with an optimized turbine to improve the overall energy conversion.
- Indigenously developed 500 m depth rated shallow water / polar remotely operated vehicle (PROVe) was successfully deployed in Andaman Islands and it explored the coral reef biodiversity in different islands with high definition cameras and scientific sensors including underwater hyper spectral irradiance meter.
- Successfully demonstrated Autonomous Coring System landing in soft sediments at gas hydrate site of Krishna Godavari Basin (1057 m depth) by designing soft foot assembly and coring was done up to 40 below sea floor in Bay of Bengal.
- Indigenously developed Buried Object Scanning/detection Sonar (BOSS) has been enhanced in terms of number of channels and sea trials successfully carried out to evaluate the reliability.
- Shore protection measures with wave energy dissipation concept were designed for Kadalur Periyakuppam and Visakhapatnam and commenced construction activities of submerged dyke at Kadalur Periyakuppam.
- Indo-Arctic (IndARC) moored observatory with subsurface sensors in the Arctic, was retrieved on July 15<sup>th</sup>, 2015 after one year of successful data collection and re-deployed with additional sensors on 19 July 2015.
- Prototype Indian Tsunami Buoy System (ITBS) - 'Sagar Bhoomi', was tested and deployed successfully in Bay of Bengal at a depth of 3320m in October 2015 and it worked satisfactorily till its retrieval in February 2016.
- Developed technology for production of extracellular glutaminase-free anticancer novel compound L-asparaginase from marine actinobacteria *Nocardiosis alba*.
- Ambient Noise Measurement System was incorporated with the IndARC 2 mooring and deployed at 190 m ocean depth at Kongsfjorden region of Arctic in July 2015 for time series noise measurements. The preliminary survey data was analysed and ice-cracking noise identified.
- Ocean acoustics team participated in International Indian Ocean Expedition (IIOE-2) during December 4-22, 2015 for measuring Deep water ambient noise.
- Technology on Drifting buoy with INSAT communication has been transferred to Indian Industry for commercialization and subsequently 20 Drifter Buoys were produced.
- Field trial of the Autonomous Underwater Profiling Drifter (AUPD) floats was successful and qualified for depth rating up to 1950m.
- Successfully implemented the rapid mode data collection process during the passage of low pressure systems in four coastal buoys to support cyclone warning endeavours.
- Operational team onboard Sagar Manjusha rescued a fishing vessel Kesavan in distress off Nagapattinam, thus saving the lives of 12 fishermen during the dark hours of 24<sup>th</sup> January 2015.
- Engineering intervention for increasing water flow into the Pulicat Lake was arrived and final report was submitted to SDSC-SHAR, ISRO and CWC for implementation.



**TECHNOLOGY DEVELOPMENT – RENEWABLE ENERGY  
AND FRESH WATER FROM THE SEA**



***0.8 m diameter straight bladed vertical axis cross flow ocean  
current turbine being tested at open channel***

## TECHNOLOGY DEVELOPMENT – RENEWABLE ENERGY AND FRESH WATER FROM THE SEA

The main area of focus of Energy and Fresh Water Group is to develop technologies for producing freshwater and clean energy from the ocean. Presently, the group is working on the following specific areas:

- Fresh water production using Low Temperature Thermal Desalination (LTTD) process and solar desalination
- Ocean Renewable Energy Forms
- Studies on increasing efficiencies of renewable energy and desalination components and processes.

### Waste Heat Utilization from Power Plants for LTTD Applications

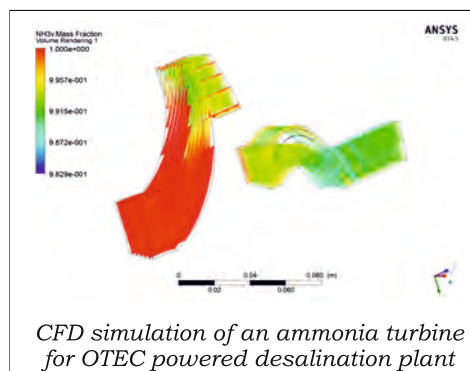
Experimental Studies continue in the LTTD plant set up in the North Chennai Thermal Power Station (NCTPS) using condenser reject heat of NCTPS as feed water to the LTTD plant. The system is being continuously operated using plate heat exchangers and fresh water of high quality was continuously generated. The water generated is stored in a large water tank and is used at the power plant premises.

### Development of turbines for ocean energy conversion

Ocean energy resources – wave energy, energy in ocean currents and the ocean thermal gradient need turbines of different types to generate mechanical power output. These turbines are to be coupled to electric generators of appropriate type. To improve efficiencies and also understand fluid, mechanical and electrical dependences, studies in the form of simulations, laboratory testing and field trials are required.

#### i) Turbines for powering island desalination plant using ocean thermal energy conversion

Ocean thermal energy conversion and low temperature thermal desalination use surface seawater and deep seawater as their main resources. Hence it is felt that LTTD plants based in U.T. Lakshadweep can be powered by Ocean Thermal Energy Conversion (OTEC) system designed to meet power requirement of LTTD plant. Two separate designs for turbine with operating speed of 8000 rpm and 12000 rpm were studied using computational fluid mechanics principles. Ammonia is the OTEC working fluid and the turbine is required to operate between 9.8 bar and 7.6 bar pressure. Further optimization of the turbine design is underway.





## ii) Ocean Current Turbines

Two horizontal axis cross flow turbines with 0.8 m diameter and 1 m length, each fitted with set of straight and helical blades, were designed and fabricated. Turbines had three blades made from Fiber Reinforced Plastic (FRP). The turbines had an underwater enclosure for housing a two stage timing belt drive, an electrical generator and instrumentation. These turbines were tested in the seawater channel in North Chennai Thermal Power Station. The performance of the two turbines matched the design and the importance of precise control on current turbine speed was understood. Current measurements at potential sites near Port Blair were carried out and a few locations were identified. Open Sea trial on the 0.8 m diameter current turbine will be conducted at one of the locations.

### Development of Low speed alternator for ocean current turbines

Permanent Magnet Synchronous Generator (PMSG) topology has been chosen for underwater electricity generation using Ocean Current Turbine (OCT) as PMSG does not require external field source. In earlier experiments on smaller current turbines, medium-speed PMSGs have been used with a step up transmission. For 1.3 m diameter turbine with design speed of 15 rpm at 0.6 m/s current speed, low speed alternators (50 rpm, 97 rpm and 250 rpm) were designed with a peak output power of 1 kW. Initially a 250 rpm design was chosen for fabrication. This will be coupled to the turbine shaft via step up transmission. This PMSG is designed with readily available materials like CR steel and N40 magnets. The fabrication of stator has been completed and other major components will be ready soon.



*Stator coil assembly and rotor for 1 kW, 250 rpm PMSG*

### Development of floating wave energy devices and impulse turbines

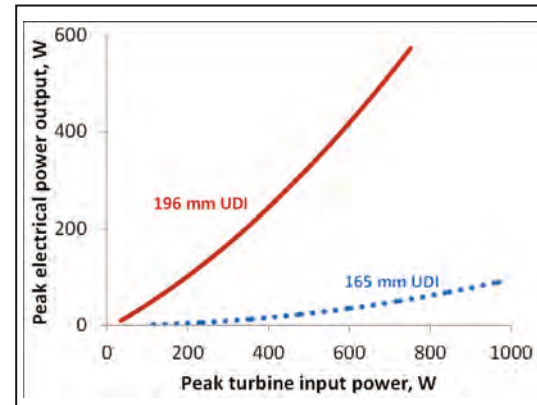
NIOT is developing Oscillating Water Column (OWC) based wave energy devices: backward bent ducted buoy (BBDB) and wave energy powered navigational buoy. Impulse turbine types – Uni-Directional Impulse (UDI) turbines and fixed guide vane bidirectional impulse (FGV) turbines – are also being developed to convert pneumatic power output from OWC

into mechanical power using suitably matching turbine. Two UDI turbines are required to operate in reversing airflow from OWC whereas a single FGV operates in both airflow directions as the symmetric rotor is flanked by guide vanes on both sides.

### Open sea trials on BBDB fitted with new turbine



*BBDB fitted with the new power module under testing off Chennai coast*



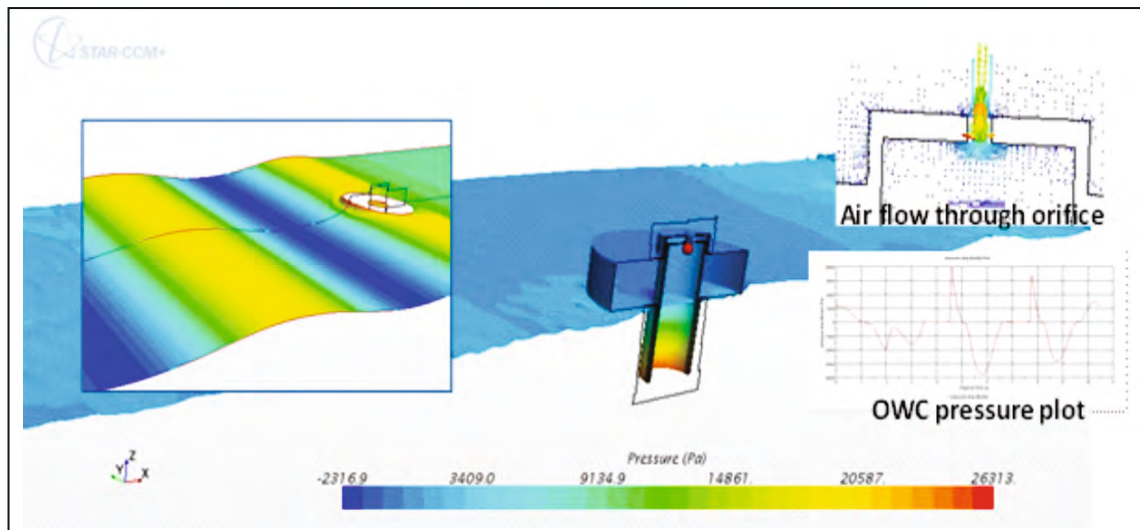
*Comparison of new 196 mm UDI turbine with older 165 mm UDI turbine*

A new 196 mm diameter UDI turbine matching the pneumatic performance of BBDB was designed and fabricated in-house. Rotor and guide vane assembly of this turbine was made using 3D rapid prototyping technique with polycarbonate material. The turbine was tested in laboratory before taking it to the field. Then open sea trials on BBDB fitted with a single unit of this new power module were conducted off Chennai coast for a period of three weeks. The wave energy buoy had four point mooring system precisely ensuring its orientation with respect to wave direction. The onboard computer collected the turbine performance and buoy motion data using different sensors. This data was continuously sent to shore station over a distance of 900 m using a wireless data transmission system. The performance data collected from this configuration indicated a significant improvement over the performance of the configuration tested earlier with the earlier turbine. The buoy was retrieved in intact condition after collecting continuous data for over three weeks. A lighter rotor ensured energy conversion even during periods with mild wave climate. The performance is in agreement that the characteristics of the turbine would match better with that of the oscillating water column as predicted by simulations.

### Wave energy powered navigational buoy

The design of a wave energy powered navigational buoy is being carried out predicting its real time performance using 3D Computational Fluid Dynamics (CFD) tool STAR CCM+. The predicted performance will be compared with the experimental studies on 1:8 model carried out in wave flume earlier.





*CFD simulation to predict navigational buoy behavior*

### **Fixed guide vane turbines**

Another type of wave energy turbines, fixed guide vane bidirectional impulse turbine, was studied in collaboration with IIT Madras. In this work, the turbine geometry was optimized using surrogate techniques by selecting sample points from a design space defined by the lower and upper limits of the design variables using Latin Hypercube Sampling (LHS) technique. Several surrogates were constructed using CFD and the turbine performance was optimized. The optimized turbine will be fabricated and tested in the laboratory.

### **Studies on Heat Exchangers and Demisters**

To monitor the various parameters the experimental setup at NCTPS was instrumented at appropriate locations to assess the performance under various conditions. During this period under report, efforts were taken to quantify the pressure drop across the demister and volumetric flow rate of non-condensable gases with uncondensed water vapour that exits from distillate condenser.

For accurate measurement of small pressure differences ( $< 50$  Pascal), a higher column length (resolution) is required to read the movement of the meniscus without proximity error. Hence an inclined manometer was used instead of an ordinary simple manometer. The indicating fluid red oil (AWS10) of  $0.87 \text{ kg/m}^3$  density was selected as it should not get evaporated at the low operating pressure. Experiments are being carried out for different demisters at various vapor velocities, achieved by varying warm water flow rates. Parallely, experiments are also being carried out to measure the volumetric flow rate of gas mixture using vortex, orifice and turbine flow meters before and after the vacuum system. Experiments are being carried out for varying and constant surface seawater flow rates.

## Setting up of LTTD Plants in Coastal Power Plants and 10 MLD Floating Vessel Mounted Desalination Plant

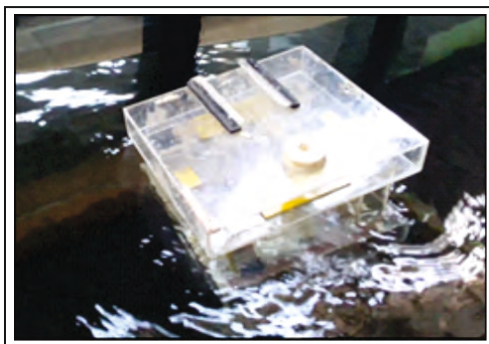
Two major projects which are being undertaken with Industrial partnership for setting up of LTTD plants are-

- A. Pre-project activities for establishing large scale desalination plant including studies on complex offshore components and thermal components.
- B. Design, development, installation and commissioning of a large capacity desalination plant using condenser reject heat in Tuticorin Thermal Power Station (TTPS) for producing drinking and industrial quality water.

A: All the technical documents were submitted by the contractor from various disciplines such as Thermal process, Electrical & Instrumentation, Offshore platform and Pipelines. These were reviewed and finalized through various discussions with the contractor. NIOT's suggestions for documents on pipeline discipline to achieve technically viable configuration have been incorporated by the contractor. Preparation of the full design for an offshore based LTTD plant is nearly completed.

Extensive studies were carried on offshore conduit related issues including VIV, clamp design etc. for 10 MLD offshore desalination plant. Numerical studies on Spar design and its installation for housing the conduit bundle were carried out as part of the in-house R&D exercise at NIOT for offshore LTTD plant. Experiments on taut and slack mooring lines using springs for station keeping of offshore platform were carried out in the wave flume. Material testing on HDPE for measuring creep and fatigue life using in-house designed experimental set up is being carried out.

B: As part of setting up of a LTTD plant in coastal thermal power station, Contractor submitted the design and drawings for Mechanical components, electrical & Instrumentation diagrams and civil structure. NIOT team reviewed it and the comments were presented in Technical Evaluation Committee (TEC). Based on the TEC suggestions, comments were sent to the contractor for further improvement. Presently revised detailed design documents for mechanical components and civil structures including drawings were submitted by the contractor and the review of the same under progress for the finalization of the detailed design.



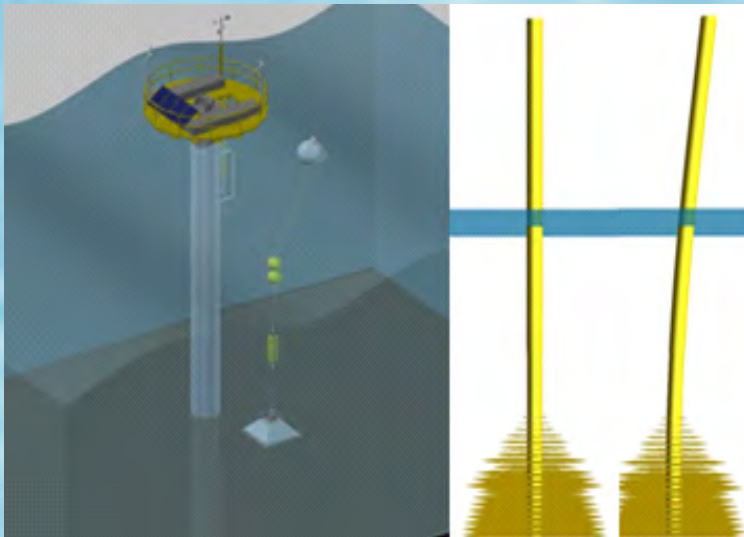
*Wave flume test of the platform model with moorings*



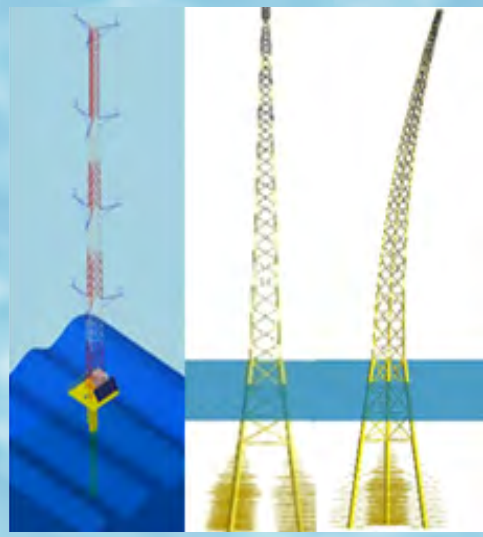
*Material testing on HDPE*



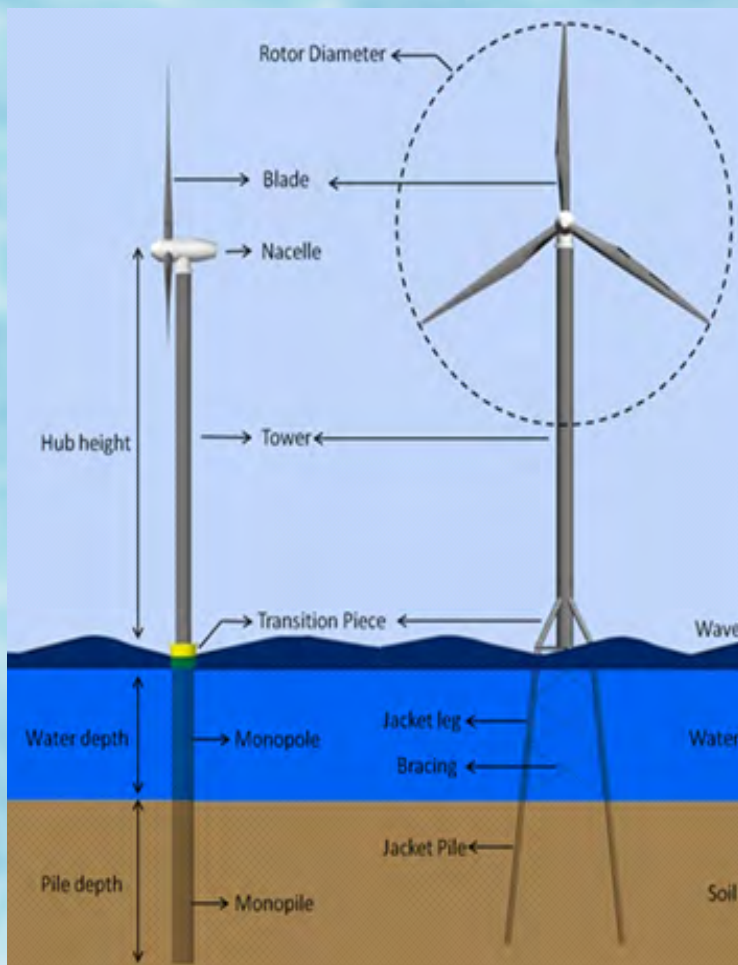
## OCEAN STRUCTURES



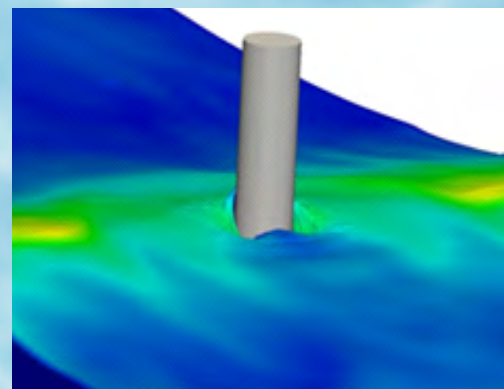
*LiDAR based Data Collection Platform*



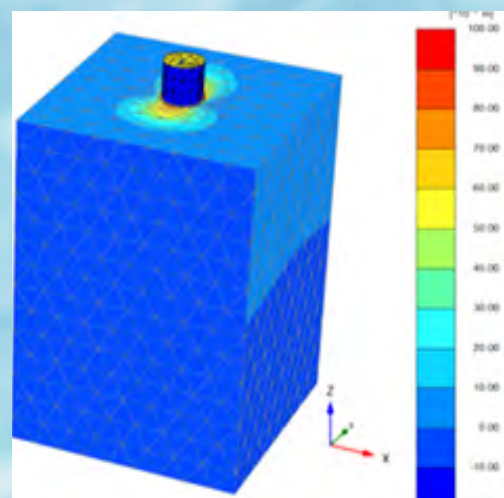
*Offshore Met Mast*



*Substructure Concepts for Offshore Wind*



*Wave Pile Interaction*



*Pile Soil Interaction*

## OCEAN STRUCTURES

The objective of the group is to provide innovative design solutions through continuous research and demonstration projects to cater to the needs of the institute programmes as well as industry, in offshore installations. The group addresses such needs and the following projects/programmes are being handled by group in XII plan.

- Establishing desalination plants in the Islands of Union Territory Lakshadweep
- Development of technologies for offshore structural components
  - Design and Demonstration of Submerged Offshore Reefs for beach restoration at Pondicherry coast.
  - Feasibility studies on Fixed and Floating platform for Offshore Wind Turbine.
  - Estimation of wave forces (breaking & non-breaking) through wave structure interaction studies.
  - To undertake preliminary work for establishing Numerical Offshore Tank facility for offshore production systems for exploration or exploitation of resources.

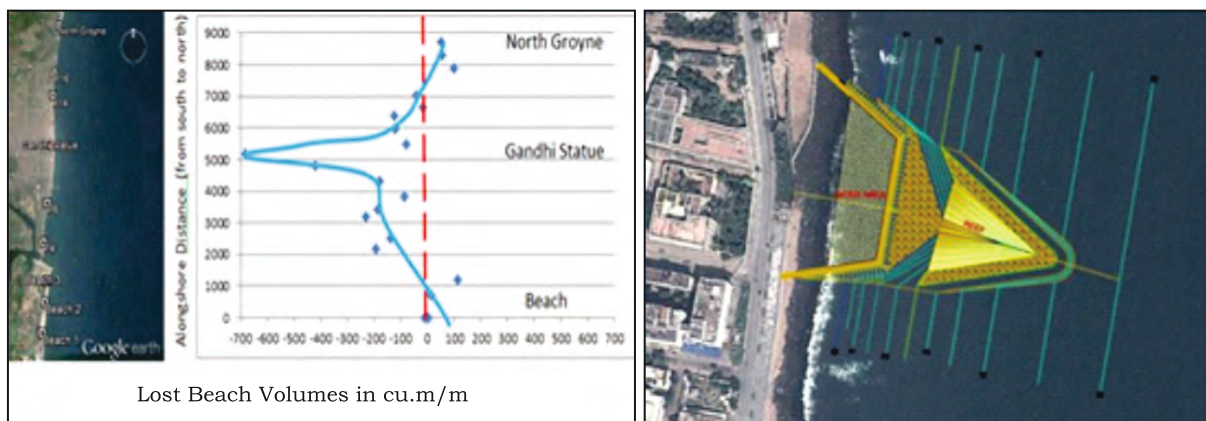
### **Design of the offshore reef with beach nourishment for coastal protection at Pondicherry**

The coastline of Pondicherry and the neighboring Tamil Nadu coastline have suffered from severe coastal erosion due to natural and anthropogenic activities. NIOT was consulted by both Pondicherry and Tamil Nadu Governments to work out long term strategies for restoration of Pondicherry coast. NIOT has recommended beach nourishment on the north of Pondicherry harbor based on the field studies and numerical modeling. Pondicherry Government has implemented the beach nourishment scheme, which showed a gain of beach to an extent of 60m. The newly formed beach received positive response from local population. Seeing the success of proposed soft solution, Pondicherry Government requested NIOT to restore the lost beach near Gandhi Statue of Pondicherry. Numerical model was established for hind casting long-term offshore wave characteristics, nearshore wave transformation, nearshore circulation, sediment budgeting and morphological changes.

- Regional Shoreline management plan for entire Pondicherry coast was completed and submitted to Pondicherry Government.
- Process based measurements for various seasons along with topography and bathymetry survey is completed.



- Based on the learning from experimental beach nourishment, numerical modeling and process based measurements one nearshore reef, one offshore reef and beach nourishment is proposed to restore the lost beach along Pondicherry.
- Methodology for implementation of beach nourishment along with design beach profiles was arrived and this indicates an immediate requirement of 1.0 million m<sup>3</sup> of sand for nourishment.
- Various configurations of nearshore/offshore retaining structures are studied to increase the life of the nourished beach and to minimize the effect of erosion on the north side.



*Layout of Proposed Solution at Pondicherry for Beach Restoration*

### **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. Developing country like India is not able to meet the required energy demands through existing installed capacities. Offshore wind being pollution free would be an ideal solution to meet this increasing demand as Indian coast is blessed with significant winds. Wind resource assessment results show high potential at Kanyakumari followed by Rameshwaram and Jakhau. Turbine with 3 MW capacities performs at high Plant Load factor at all the 3 locations along Indian coast when compared with other commonly available turbines in range of 1.5 to 5MW. Aerodynamic loads on wind turbine were estimated using open source codes FAST and SOWFA for various load conditions as per IEC standards. Preliminary design of three substructure concepts monopile, gravity and jacket based on static and earthquake analysis are completed.

- Design of Lidar based data collection platform at Jakhau, Gujarat for M/s Suzlon is completed, environmental clearance is obtained from GCZMA and contractor has been identified for implementation.

- A detailed report on data collection platform at gulf of Khambhat has been submitted to Ministry of New and Renewable Energy, National Institute of Wind Energy and FOWIND for implementation.
- Detailed geotechnical investigations are carried out at Jakhau and Navlakhi, Gujarat by mobilizing jack-up barge.
- Detailed methodology for pile-soil interaction is developed for safe and optimum design of large diameter monopiles.
- Numerical model is setup for Monopile using open source code 'OpenFOAM' for reliable estimation of hydrodynamic forces under extreme events.
- Design of Guy-wired mast on suction piles and free stranding mast on jacket for varied soil conditions has been initiated.



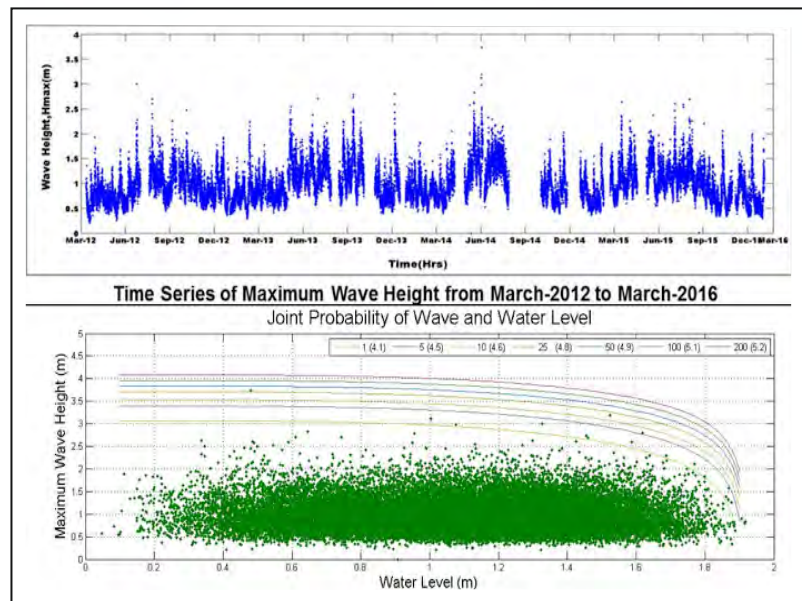
*Geotechnical Investigations at Navlakhi, Gujarat by mobilizing jack-up barge.*

### **Estimation of wave forces (breaking & non breaking) through wave structures interaction studies**

Wave structure interaction studies to estimate the reliable wave loads on structures were initiated based on the experience of Agatti desalination project, which was subjected to damage due to high wave loads. The objective of this study is to estimate wave loads on structure by measuring the wave pressure on seawater intake caisson, which will be used in optimize the design of such marine structures in future.



- Full scale experiments are being continued on seawater intake caisson/structure at Agatti, where wave (incident & reflected) and tidal parameter are measured continuously from March 2012 to April 2016 (more than 4 years) by bottom mounted directional wave recorders.



*Time series of maximum wave height*

- Hydrodynamic measurements collected as part of Full scale experiments are relatively for shorter durations. However, for reliable estimation of extreme wave events through probabilistic approach, wave climate will be required for decades. So, a two stage nested wave model for Lakshadweep Islands was setup with wind as forcing parameter. The model was validated with available offshore wave data measured by data buoy and is showing good agreement.

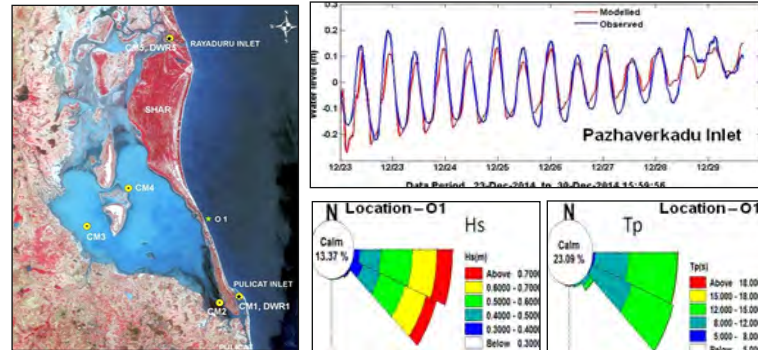
### **Development of Numerical Offshore Tank Facility for offshore production systems for exploration or exploitation of resources**

The Detailed Project report for establishment of offshore numerical tank was finalized and has been submitted to MoES for approval and is in process.

### **Bathymetry and Hydrological study for Pulicat Lake**

Degradation of Pulicat Lake ecosystem surrounding the Sriharikota Island is causing severe security risk to SHAR. The local village people are facing problems with low fish production, siltation in navigable channels, water pollution and inundations during the time of river floods and cyclone disasters. SHAR Management has requested National Institute of Ocean Technology (NIOT), to develop scientific solutions for ensuring water inflow into Pulicat Lake which will restore the ecosystem.

Numerical studies indicate that the opening of SHAR inlet will improve the water flow in the northern regime of the lake (approximately 18% of the lake). The opening of new mouth about 300m wide at Pulinjery Kuppam/Tettupeta will facilitate

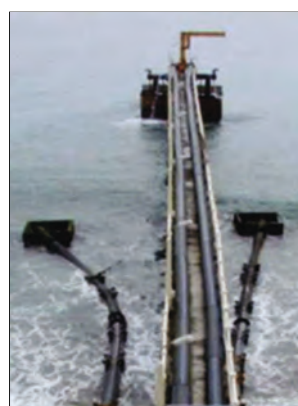


*Hydrodynamic measurements at pulicat lake*

effective flushing of water flow about 89% inside the lake and the final recommendations were submitted to SHAR Management. Central Water Commission (CWC) has constituted a committee to examine the technicalities in opening new mouth to increase water flow inside the Lake. Based on CWC recommendations, the measurement of physical parameters inside the lake were carried out. The study of NIOT covers the entire Pulicat region in the Andhra Pradesh and to the limited extent in Tamil Nadu region. Since, southernmost inlet lies in the territory of Tamil Nadu and may have impact on the proposed opening of mouth at Tettupeta, the study has been extended to Tamil Nadu region also.

### **Development of alternate materials for Desalination and other offshore structural components**

Submarine pipelines laid for the intake of seawater for desalination process are often subjected to oscillations due to combined action of wave and current in shallow water region. The study focused on application of alternate material, Glass Fiber Reinforced Polymers (GFRP) for submarine pipeline for island desalination projects, in place of conventional HDPE or steel pipes, considering merits such as corrosion resistance, better thermal insulation, less maintenance and long life. GFRP pipes were fabricated and tested for their usage in marine environment. The outfall pipes in LTTD desalination plant at Minicoy are replaced with GFRP pipes and the performance of GFRP pipes are being studied.



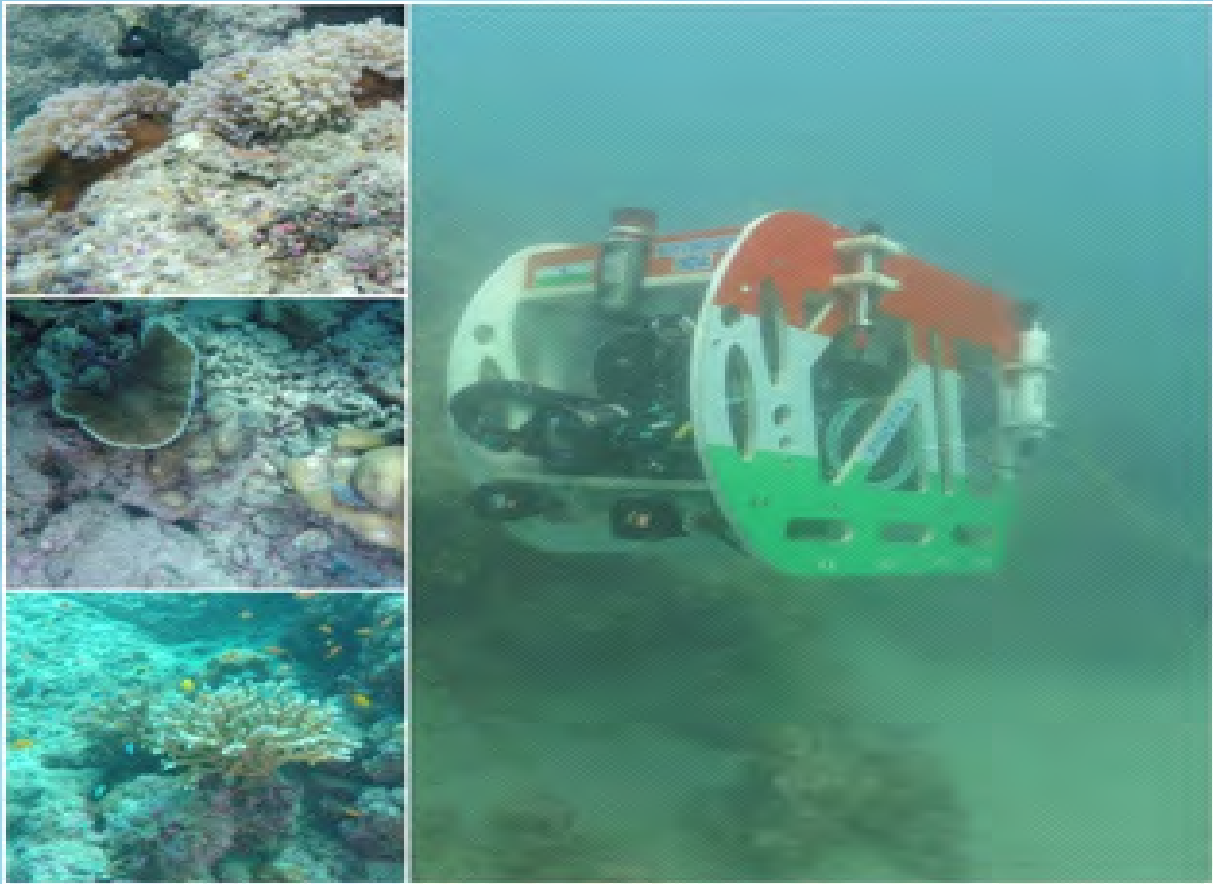
*a) Damaged HDPE outfall pipe at Minicoy Island*



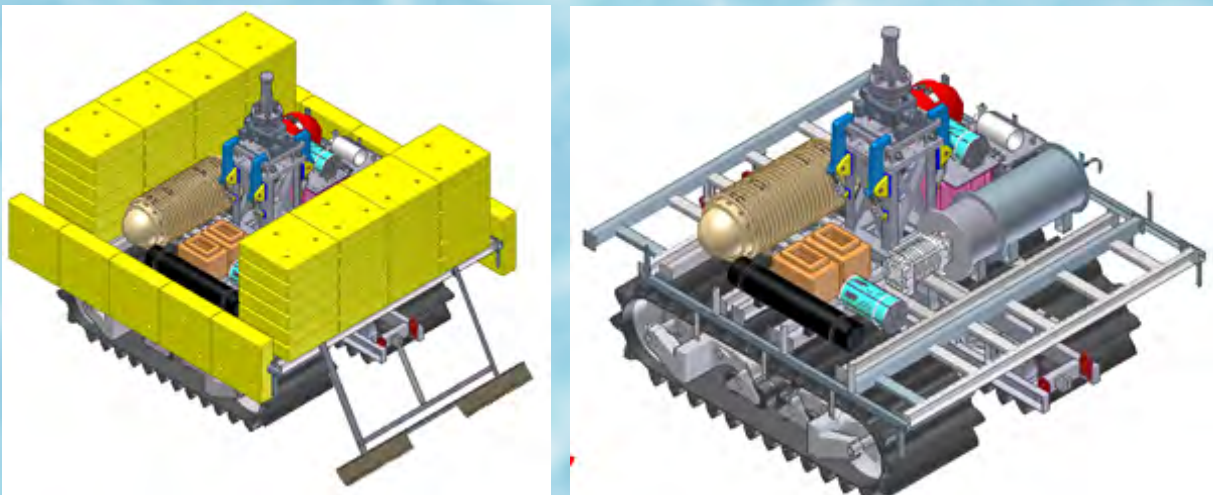
*b) Replaced GFRP outfall pipe at Minicoy Island*



## DEEP SEA TECHNOLOGIES



*Coral reef exploration using shallow water ROV (PROVe) at Andaman Islands*



*Experimental undercarriage for deep ocean mining machine*



## DEEP SEA TECHNOLOGIES

The objectives of the Deep Sea Technology group is to develop technology for the exploration and exploitation of deep ocean mineral resources such as poly-metallic manganese nodules, gas hydrates, hydrothermal sulphides and for other deep ocean/polar and industrial applications.

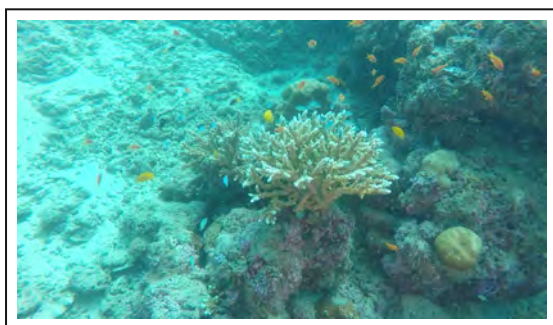
### **Coral reef exploration using Shallow water / Polar Remotely Operated Vehicle (PROVe)**

PROVe is an underwater Remotely Operated Vehicle (ROV) designed and developed indigenously for shallow water applications up to 500m and capable of operating in polar and open ocean environmental conditions. System was deployed at Andaman Islands during March 2016 to explore the coral biodiversity and vehicle maneuverability in highly undulating coral reef terraces. Hyper spectral radiance and irradiance sensor was augmented with ROV to understand the sun light penetration in coral reef region.



*PROVe deployed in Andaman*

ROV subsystems such as underwater vehicle, console unit for piloting the vehicle, power systems, umbilical cable etc. were assembled in a fishing trawler for the exploration. Vehicle was deployed using chain pulley block arrangement from the trawler and operated up to depths of 30 m in five different locations of Andaman (North Bay, Chidiyatopu, Jolly buoy, Grub and Redskin islands). The vehicle maneuvered upto a speed of 2 knots and in total 14 dives were made at different locations in the Andaman Islands with the support of Andaman Fisheries and Forest departments. Sea bed images, diversified varieties of corals, fishes and associated biological organisms were captured using high definition underwater still and video cameras. Data from scientific sensor such as spectral radiance, underwater spectral irradiance, water temperature, salinity, conductivity, dissolved oxygen, altitude, depth and attitude were acquired continuously during coral reef exploration. The collected coral reef images by the ROV are shown below. It was found that the corals are healthy and started growing after its degradation due to Tsunami event during December 2004.

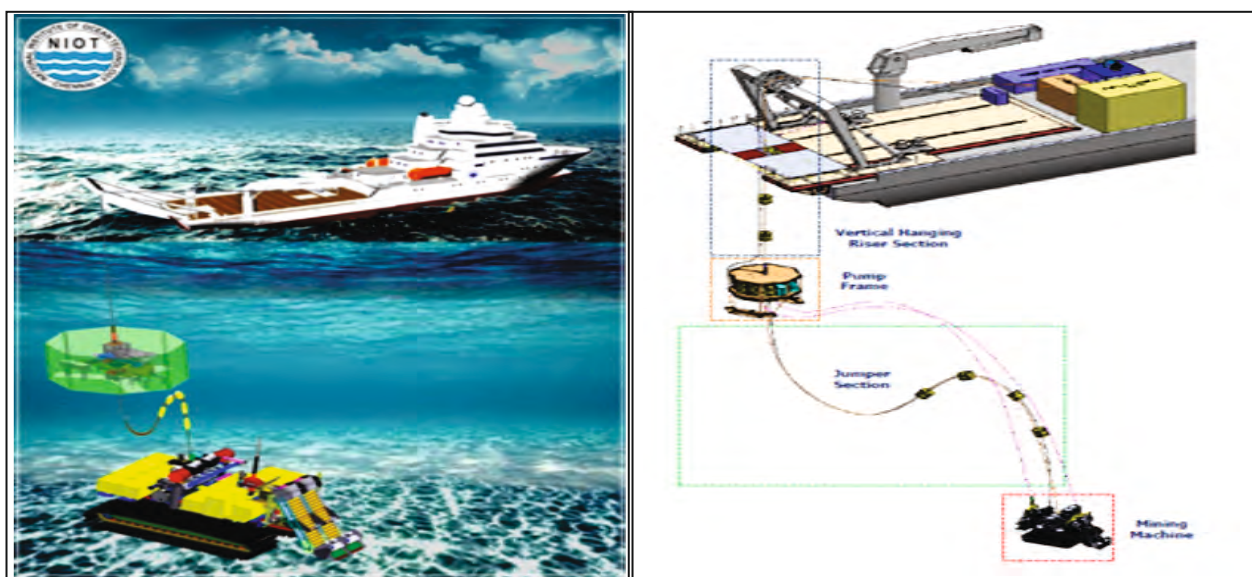


*Coral reefs collected in south Andaman Islands*

## Integrated Mining System

Crawler based Integrated Mining System (IMS) is in an advanced stage of development for mining the polymetallic manganese nodule which are rich in Manganese, Cobalt, Nickel etc. and occurs at 5500 m water depth at Central Indian Ocean Basin which is approximately 3000 km south of Chennai in Indian Ocean. Modular level tests of the deep water crawler subsystems and pumping platform's components being undertaken to qualify the subsystems for its integration. To operate the crawler at low bearing strength deep sea floor and mine the nodule from the deep sea nodule field, studies pertinent for the development of the subsystems such as sinkage and pullout tests, under-carriage and grouser optimization, configuring the slurry pump and riser system for pumping the crushed manganese nodule to the surface, mitigating the adverse effects of temperature rise in umbilical coiled on a winch during use, redundancy of underwater communication for control and data transfer etc were undertaken and ready for field testing.

Concurrently, proposed mining machine configuration was arrived at from the experienced offshore consulting firms as a consultancy-study titled “Configuration and Handling Studies of Flexible Transport Riser System”. The study was concluded with M/s 2H Offshore Engineering, Malaysia, a leading offshore consultancy firm specializing in riser systems. The study was commissioned to evaluate all the options for deep sea mining using a flexible riser system, using ORV Sagar Nidhi as the base vessel, with specific application at the test mining site at CIOB with the most extreme weather conditions. The study report submitted by 2H offshore has brought out the best possible options for mining in the area with focus on the riser configuration, high pressure slurry flow management, launch-recovery protocol from the vessel ORV Sagar Nidhi.



*Conceptual design for 6000m deep sea mining machine*



## Development of undercarriage for the mining machine

The crawler based mining machine needs to operate on the soft sea bed at polymetallic mining site at Central Indian Ocean Basin (CIOB). The soil property measurements by the in-situ soil tester equipment revealed very low bearing strengths of the sea bed at the Test Mining Location (TMS) in Central Indian Ocean Basin (CIOB). Further from the land based test results of the scaled model of the undercarriage in bentonite soil bed had necessitated in-situ measurements of various design parameters to optimize the size of undercarriage for Integrated Mining System (IMS).

It was proposed that the existing tracked undercarriage system be configured with a latching system and modified plough to measure and study the dynamic riser loads on machine during locomotion. The undercarriage is specially modified to measure the following parameters in-situ.

- Validate efficacy of tracks for locomotion at deep sea mining site in CIOB
- Estimate riser loads on machine during locomotion
- Estimate static and dynamic sinkage of undercarriage system
- Establish re-moulding effects of soil after disturbance by pick-up
- Twisting of undercarriage system umbilical during deployment and retrieval
- Estimate the slip of the undercarriage system

In order to reduce the weight of the present system in water the buoyancy modules are being used to achieve the contact pressure of the undercarriage system. The specifications of the experimental undercarriage system is given below,

- Weight of the system in Air : 10.5 Tonnes
- Weight of the system in water : 2.5 Tonnes
- Contact area : 4.2 m<sup>2</sup>
- Contact bearing pressure : 6 kPa
- Operating speed : 0.15 to 0.5 m/s

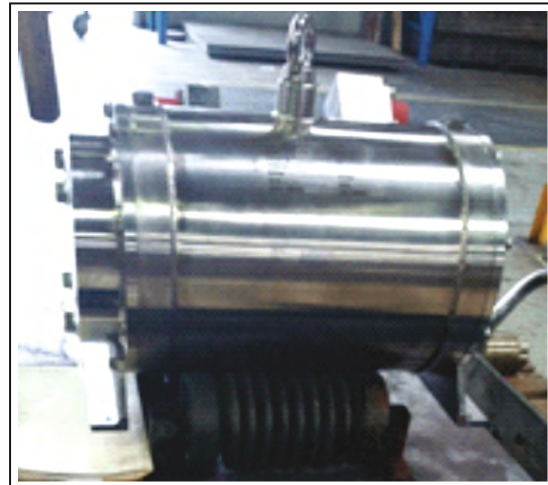
## Sub component developments

The experimental undercarriage is fitted with a 30kW, 3000V, sub-sea induction motor to drive the Hydraulic power units for its traffic ability controls. The motor is pressure tested and qualified in hyperbaric chamber to operate at 600 bar external pressure. The motor is customized to NIOT requirements and interfaces.

A dedicated latching system was designed with underwater load cells and fabricated on the lifting tower of the undercarriage. The latching system isolates the underwater load cells from the mining machine during launching /retrieval operation, however allows measuring the drag loads coming on the mining machine during locomotion on sea bed. The system was qualified in NIOT with dummy loads.



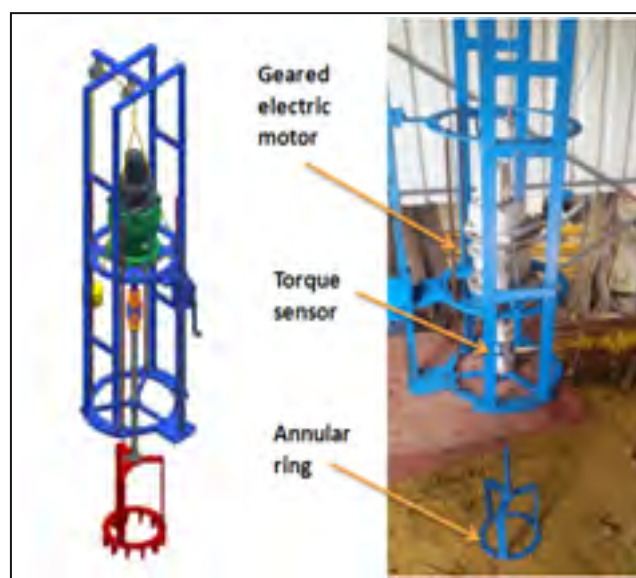
*Latching system with underwater load cells*



*30kW, 3000V, 3Ph sub-sea electric motor for undercarriage*

### Soil Interaction Studies

A Bevameter was designed to study the shear force offered by soil and works on the principle of Bekker. The shear tests helps to establish the shear stress to displacement relationship for very soft clays, which helps us to predict the traction forces based on slip.



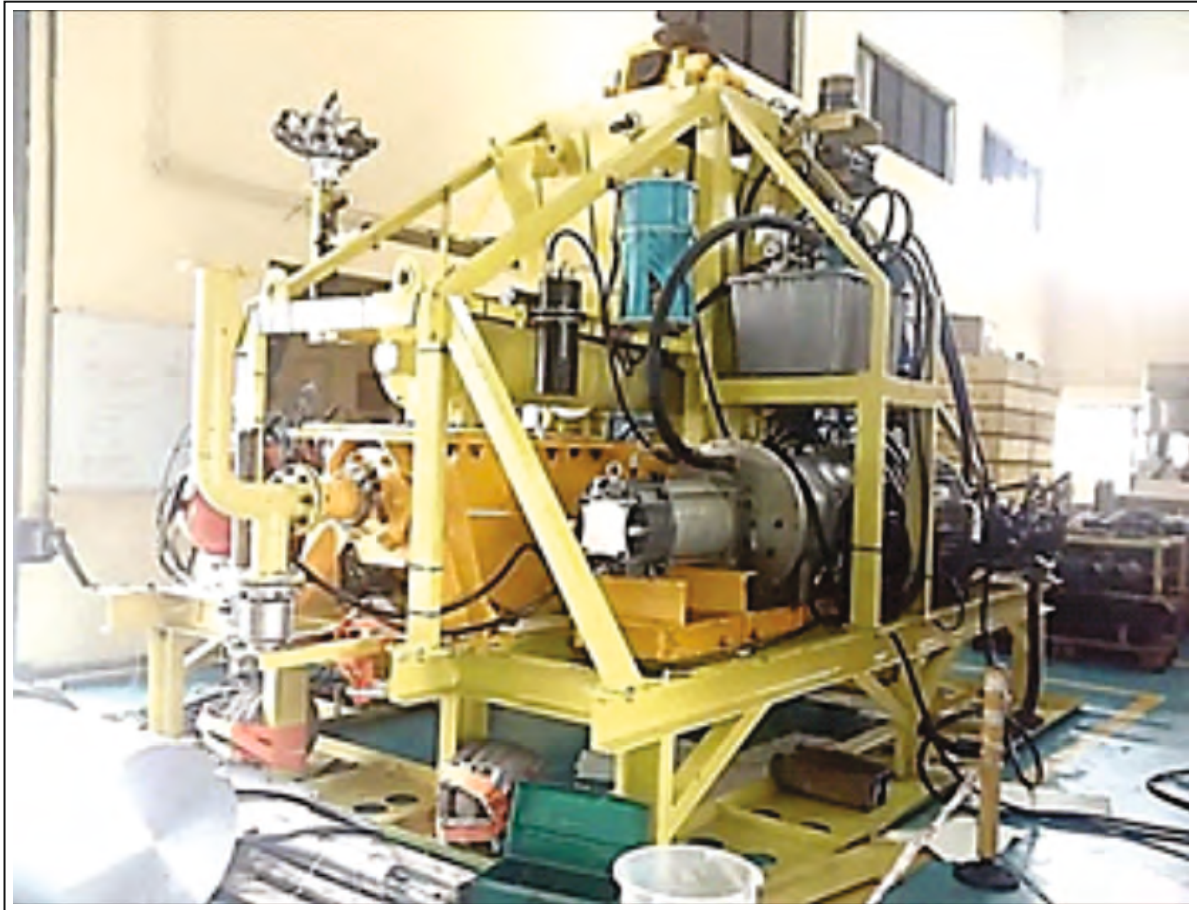
*Testing of Bevameter in Bentonite soil bed*



The study aims to identify the shear parameters for very soft clays less than 3kPa that can be used to predict the traction of the tracked vehicle. Experimental studies were performed in bentonite soil bed. The influence of the bevameter test set up variables like pitch, height and width of the vane on the shear parameters were studied in the test.

### **Pumping system characterization**

A pump test platform is designed and fabricated to study the pump and slurry flow characteristics for a pulsatile flow along a vertical riser to send the mined nodule from the deep sea floor to the ship. A positive displacement pump will be used in the platform and operated at a depth of 250-300m below the mean sea level. Underwater pressure sensors with localized data logging will be positioned at different locations of the vertical riser. The pressure data obtained from these pressure sensors will be used to obtain the pressure drop profile along the flexible hose during the pumping operation. The pressure sensors are modified and isolated from the slurry to prevent from clogging. The pressure profile obtained can be used to optimize the flexible riser design for the IMS system. The system is fully integrated and tested in land to obtain the reference characteristics.



*Pump test platform*

## Gas Hydrates

Under the Gas Hydrate program, NIOT is involved in development of exploration tools and extraction feasibility studies of gas hydrate with reference marine gas hydrate reservoir settings of India. Autonomous Coring System (ACS) development by NIOT in collaboration with M/s Williamson & Associates, USA had been completed. By design, the system is capable of collecting 100m core from deep ocean basins with wire-line technology at a maximum water depth of 3000 m. Based on experiences with the previous sea trials in the Krishna Godavari (KG) basin where the shear strength of soft sediments are in the range of ~ 1 kPa, soft feet assembly design and development were carried out and incorporated with the leg assembly.

Hydraulically operated foldable soft feet was assembled, integrated and tested along with ACS leg assembly. ACS was lowered safely from the deep sea winch of Sagar Nidhi on the sea bed in KG basin site at a depth of 1057 m and was tested for sinkage on sea floor for further coring operation as shown below. The system was operated at gas hydrate site for 18 hours continuously and drilled with casing up to 24.15 mbsf at 1057 m water depth as shown in the figure. Sea floor drilling with the wire-line technique of ACS was successfully performed at 816 m water depth at Chennai offshore during May 2015 and drilled upto 40mbsf. System encountered hard patch rock fragments from 17 m onwards upto 40 mbsf.



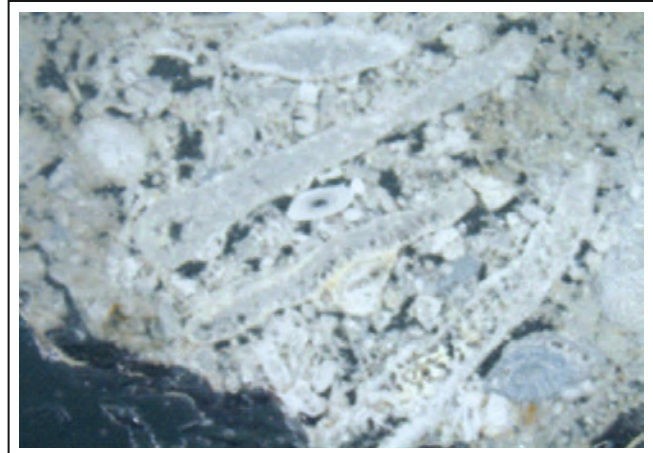
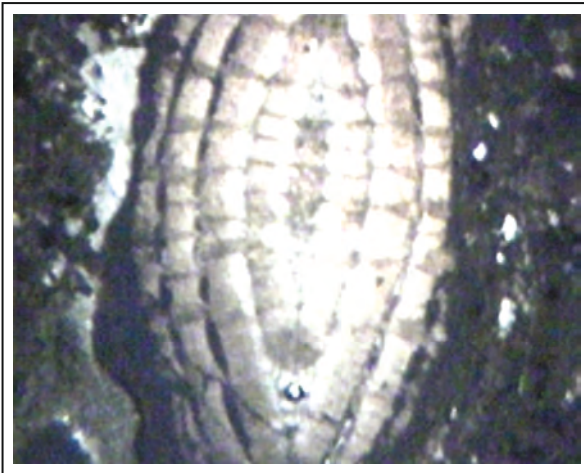
*View of the ACS onboard Sagar Nidhi*



*Underwater drilling operation*

Recovered core sample in the inner tube showed porous calcareous rock material with abundant shells and the petrological investigations have shown that it is coralline Nummulitic Limestone of Eocene age.

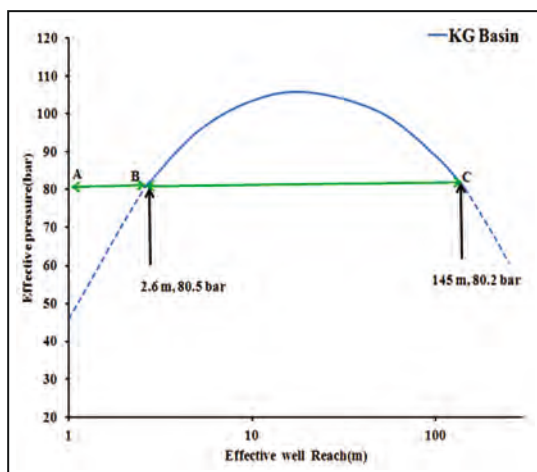




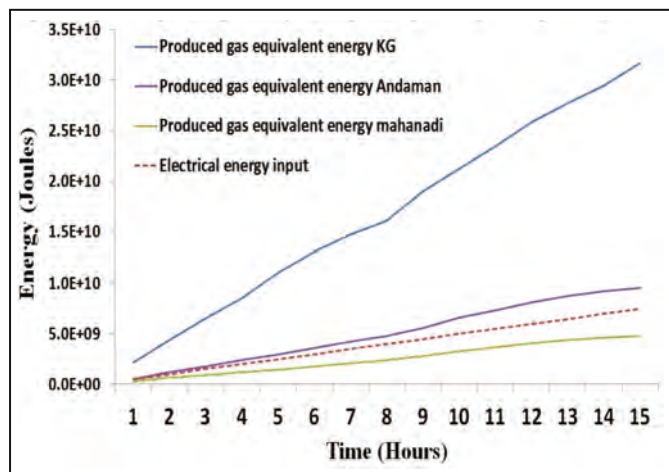
*Petrological thin section photograph of Nummulites and coral filaments*

### **Extraction of methane from the Gas Hydrates reservoirs in Indian continental margins**

The group is involved in developing a suitable technology for the extraction of methane from the Gas Hydrates reservoirs in Indian continental margins. By considering the petro-physical reservoir properties in the Krishna - Godhavari, Mahanadi and Andaman reservoir settings, mathematical modelling and simulations were performed using MATLAB code and reservoir modelling software TOUGH + HYDRATE to identify the efficacy of the depressurisation and electro-thermal techniques. It was identified that in the KG basin, thermally-aided depressurisation technique could dissociate gas hydrates up to a distance of 145m from the well bore as shown in the figure. The in-situ electro-thermal technique will be effective in the KG and Andaman reservoirs; and in the Mahanadi reservoir, if the gas hydrate saturations are greater than 17% as shown in the figure.



*Electro thermal and depressurization technique for KG Basin (10D)*



*Comparison of electro thermal dissociation techniques in Indian reservoirs*

### **Development of upgraded version of In-situ Soil Tester**

Remotely operable In-situ soil testing system for 6000 m depth operation is developed by converting the hydraulic system to fully electrical system along with additional features for vibration sinkage measurement for use in Integrated Mining System Development Project.

One of the most critical parts of the IMS development has been the capability of the Mining Machine to effectively move and maneuver on the extremely soft soil of the seabed at CIOB. Since the data on the soil strength at site, in as-it-is condition, was most critical for developing the locomotion system of the Mining Machine, an in-situ Soil Tester has been developed to measure the same at in-situ condition. The Equipment can be deployed from a ship to a depth up to 6000 m and can effectively measure the soil shear strength and bearing pressure up to 40 cm, apart from image profiling of the sampled location. The Equipment has also been augmented with a vibration module to impart vibratory loads on the soil surface to study the soil response, in simulating the similar effects during the use of the Mining machine. It is intended to adequately map the test mining site area at CIOB with the Soil Tester before the actual deployment of the IMS for mining. System development is completed and ready for taking insitu measurement at CIOB for soil properties.



*In-situ soil tester with vibration sinkage system*

### **Homing-Docking and Sensor fusion**

Wireless power and data transfer, vehicle attitude with position estimation using dead-reckoning aided with acoustic positioning systems and vision based vehicle guidance are required for realising an efficient homing and docking system. These systems are used for deployment and retrieval of deep sea autonomous vehicle (AUV) from the base vehicles which are connected through an umbilical cable.

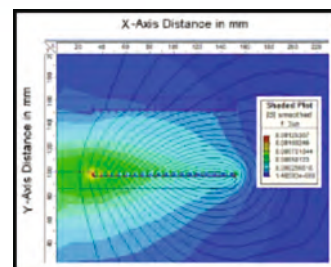
Subsea Inductive power transfer (SIPT) is one of the efficient and reliable methods for limited power between underwater docking station and AUVs. The technique shall ensure increased endurance in deep waters reducing the ascent and descent time. Using electromagnetic finite element analysis and in-house experimental prototype development, the power transfer performance is analysed using different type of water as shown in the figures below. The results indicate that the power transfer efficiencies vary from 63.4% to 1 % for water gaps ranging from 50 to 500 mm respectively at an operating frequency of 125 kHz. It is also found that coil of 0.5 m radius could be required to transfer about 50 kW at 50 mm water gap, at 50 A current.



Prototype wireless optical data transmission is demonstrated in the lab involving a data rate of 100 kbps at a distance of 0.5 m in a closed clear water environment. Further efforts are undertaken to increase the data rate and at increased distances so as to support underwater data and video transmission enabling vision based docking.

### **Human Occupied Vehicle**

NIOT is involved in developing Human occupied vehicle (Manned Submersible) for 6000 m operation. Proposal with complete contract document with identified Russian and Indian consortium was prepared and legal ministry vetted document was submitted to Ministry for final approval to proceed with the project. In-house expertise developments are in progress for the subsystems development such as personnel sphere with spherical hull, life support system, power budget, underwater battery etc.



*Modeling and SIPT prototype testing*

### **Inter institutional R&D projects (PMN) (XII plan)**

The need for carrying out basic research and familiarizing deep-sea mining activities with the universities and associated R&D institutes was felt essential and a few critical areas were identified with institutes to understand the basics in detail.

### **Soil- Machine Interaction Studies on Deep Sea-bed Poly-metallic Nodule Mining Systems**

The project deals with studying the interaction of soil-collector and hydrodynamic resistances encountered during mining operations. Laboratory facility has been developed at Anna University under inter-institutional R&D. Testing of the pick-up-collector system is to commence shortly.

### **Development of high strength to weight ratio materials for the body of unmanned underwater vehicle**

A project on development of high strength to weight ratio materials for the body of unmanned underwater vehicle was taken up with IIT Kharagpur. The work aims at developing metal matrix nano composites (MMNC) materials. Al-5083 castings with infused alumina nano particles have been completed to lab scale and the resultant material has been observed to have superior properties as compared to the base metal. The project has been completed.

### **Dynamic analysis of deep sea polymetallic nodule mining crawler for enhanced speeds in soft soils**

A project on kinematic and dynamic analysis of different configurations of undercarriage including various grouser shapes for increased locomotion speed has been taken up with IIT, Chennai. Mathematical modelling and experimental study is being undertaken to develop the characteristic property curve of soft soil when worked upon.

## OCEAN ACOUSTICS & MODELING



*Deployment of Ambient Noise Measurement System in Arctic*



## OCEAN ACOUSTICS & MODELING

The Ocean Acoustics programme is focussed on development of real time passive acoustic measurement systems, vector sensor arrays for source localization, sound propagation modelling, underwater acoustic communication systems and upgradation of Acoustic Test Facility (ATF).

### Ambient Noise Measurements in the Arctic Region

The objective is to record time series of ambient noise data in the Arctic region and to study the dynamics of the sea ice cover, movements and oscillations of ice flows/ fields and various mammal noise. The Ambient Noise Measurement System (ANMS) along with the IndARC 2 mooring was deployed on 19/07/2015 at 190 m ocean depth at Lat: N 78°56.789' and Long: (E 12°00.889').

Ambient Noise Measurement System for the Arctic Region consists of a hydrophone (Cetacean make) with cable and the Data Acquisition System (DAS) with indigenously developed underwater pressure casing. This has been incorporated in the IndARC mooring and fixed in a PVC fixture to avoid bio-fouling and corrosion. Data acquisition system consists of NI based data acquisition card along with a processor card and flash drive memory of 128 GB. The DAS is designed for data collection over a period of 8 months, with a sampling rate of 50 kHz, for 60 sec duration and 8 data sets per day. The system has been subjected to pressure testing, buoyancy testing and environmental chamber testing.



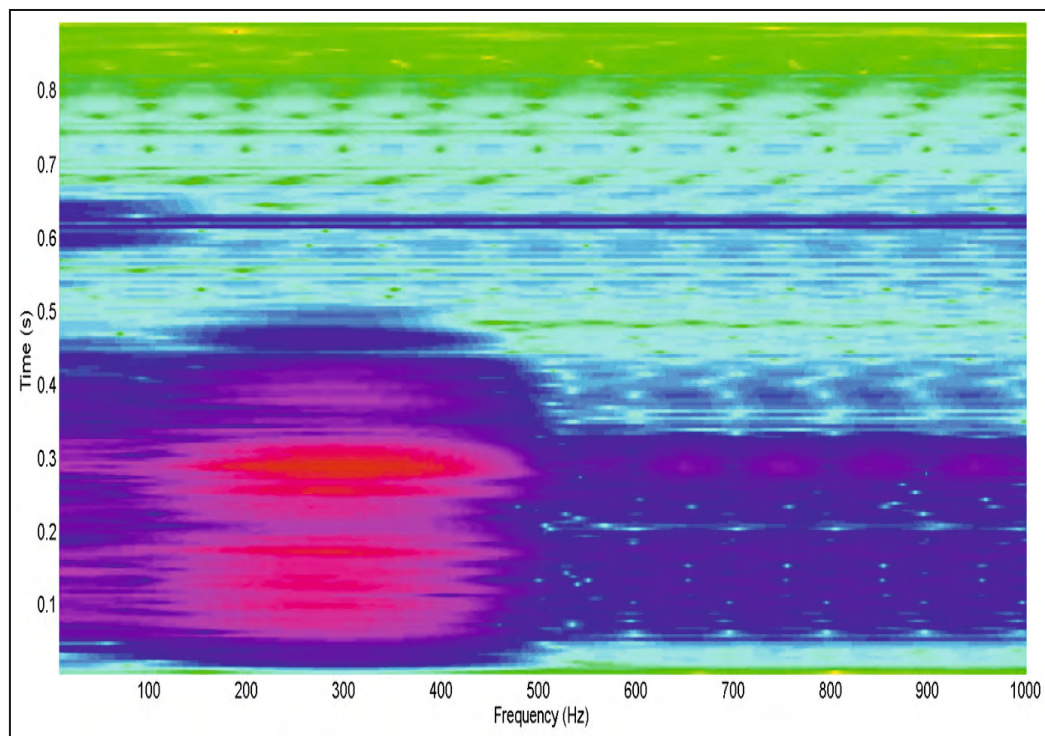
*Hydrophone and DAQ with Underwater Pressure casing*

*Deployment of ambient noise measurement system*

### Arctic Ambient Noise Analysis: Ice berg cracking events - Kongsfjorden fjord

Prior to deployment of IndArc system, a preliminary survey was conducted at the location for one day on 19<sup>th</sup> July 2015. The hydrophone was placed at 5 m water depth, where the ocean depth is 50 m. Noise data sets were acquired at a sampling rate 50 kHz for a duration 60 s with 16 bit resolution. A sequence of approximately 8 events of cracking are observed in which three are of high intensity and five are of low intensity noise. It is observed that the

entire ice berg calving noise falls in the frequency band 100-500 Hz and ice berg bobbing noise in the band 200-400 Hz. During this experiment, visual observations of the ice cracking on the surface of ice-berg were made. Cracking noise was audible to the unassisted ear. The noise signature considerably varied in between bangs and crashes with their echoes tending to irregular cracking. The spectral noise level grasped an extensive maximum in the frequency band 100-500 Hz. The noise at or nearby the surface of the ice berg and were mainly due to the ice berg calving and bobbing, which were caused by the thermal expansion in the ice.

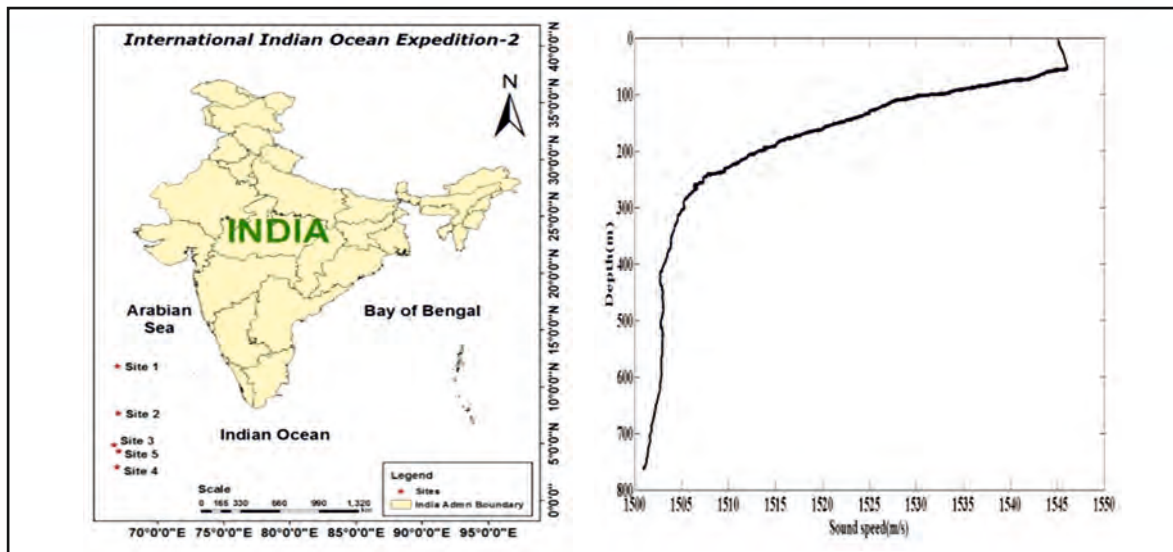


*Spectrogram of the Ice calving and bobbing noise*

### **International Indian Ocean Expedition 2 (IIOE -2):**

Ocean Acoustics group of NIOT participated in IIOE-2 on ORV Sagar Nidhi for measuring deep water ambient noise, from Goa to Mauritius during Dec 4-22, 2015. Ambient noise was recorded using hydrophone up to 60 m of the water column. Measured data set can be used for the spectral and spatial characterization of background noise in deep water. The data provides insights about the directionality pattern of ambient noise up to 60 m depth and later can be used for the theoretical modeling of noise spatial characteristics such as directionality and coherence. In addition to ambient noise, other environmental information, such as wind speed and sound speed profile from the sites were also collected.



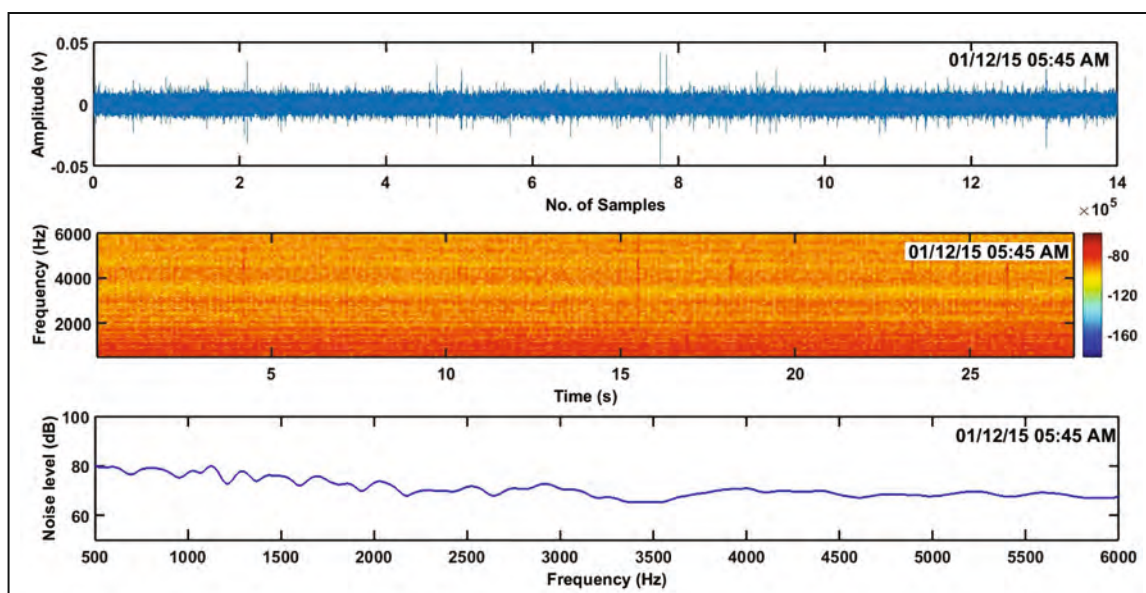


*Data measurement points and corresponding sound speed profile at site 1*

### **Locations of measurement, sound speed profile and ambient noise spectrum.**

### **Establishment of network of ambient noise stations along the east and west coast of India: Deployment of System off Goa for Underwater Ranges, Naval Unit, Goa**

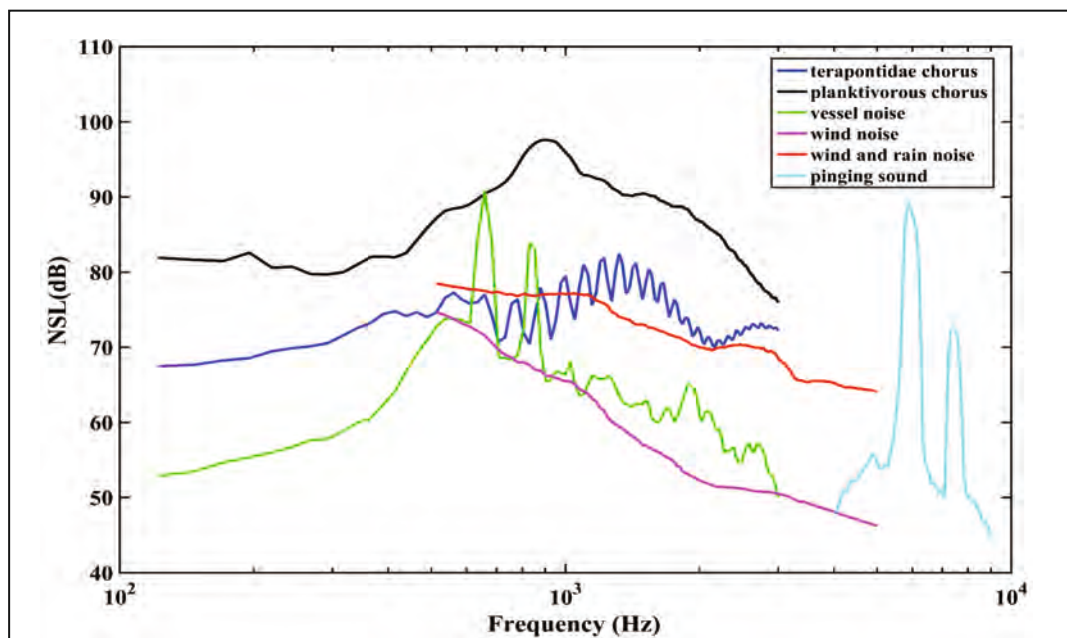
Deployment of system off Goa at 30m depth and data collection during October 2015 to January 2016 was completed as per the request of Naval unit Underwater Ranges (UWR) Goa. The data collected using 21 element array has been analysed and shared with UWR Goa. Ship engine noise has been identified and shown below. A complete report on the data and analysis has been sent to UWR, Goa.



*Waveform, spectrogram & spectrum of ship engine noise off Goa*

### Bioacoustics- Soundscapes in the shallow waters off Goa, west coast of India:

Monitoring the soundscape or acoustic environment represents an important part of the ecosystem management. They provide important sensory information about marine species that reflect the changing biological and physical characteristics of the environment. The analyzed data indicates that the ambient noise in the shallow water off Goa is dominated by geophonic, biophonic and anthropogenic sources. The geophonic sounds are mainly attributed to atmospheric wind, whereas the biological signals are generated by the chorus of Terapontidae and Planktivorous. The anthropogenic in this region has increased through vessel and shipping activities. The soundscape in shallow waters off Goa is shown in the figure below.



*Soundscape in shallow waters off Goa*

### Soundscape in the shallow water off Goa, west coast of India.

The present study plays an important role in the ecology of shallow water environment, and passive acoustic measurement is a key element to understand the acoustic ecology.

### Development of a shallow water model for high frequency ambient noise:

An ambient noise model developed based on ray theory to predict the spatial noise properties and noise level due to wind was tested successfully in different sites. Comparison of model spatial properties with OASES has been carried out. Reflection loss is calculated by including seabed roughness in the OASR and later used in the ambient noise model.



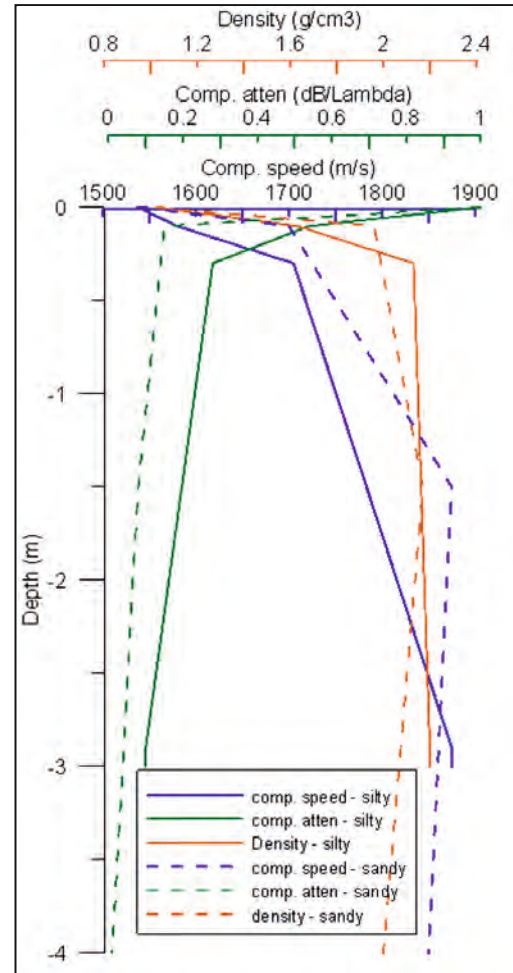
### Seabed classification/characterization using underwater acoustics:

Seabed parameters (compressional / shear speed; density; compressional / shear attenuation and layering) have been estimated for a silty and a sandy site using coherence based inversion. The inversion was attempted for a silty site (absorptive) and a sandy site (reflective). The results have been published in JASA Express letters.

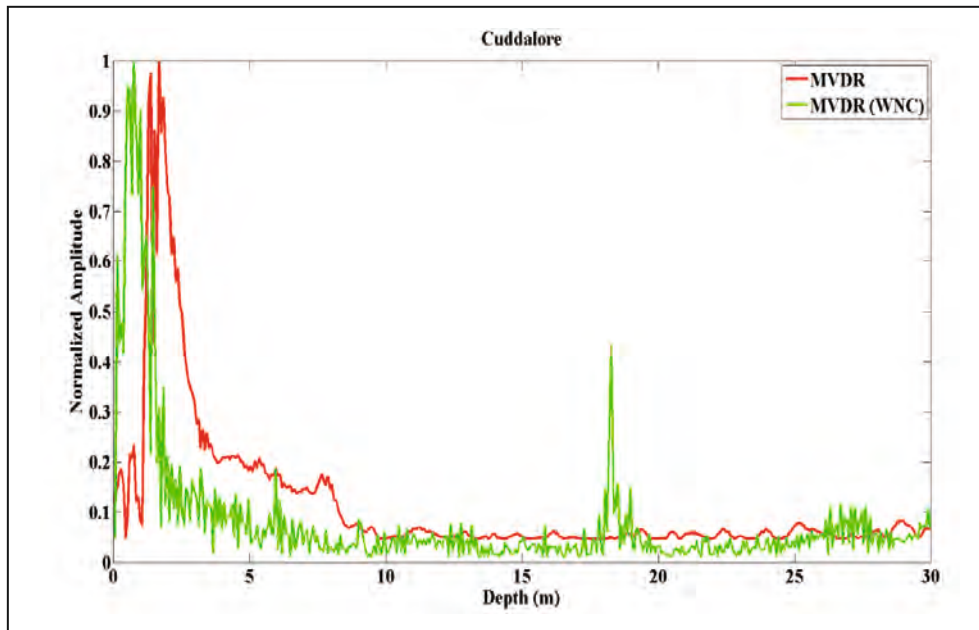
Further to this, a technique based on vertical directionality that has been widely used for estimating seabed properties, is tried out here. The ratio of upward looking beam to downward looking beam produce an estimate of reflection loss of the seabed. Measured noise acquired at a site off Chennai is used for demonstrating the possibility of inversion. The data retrieved from a 21 element array with inter element spacing of 7.5 cm (corresponding to a frequency of 10 kHz), deployed off Chennai for a period of 1 week is used for the study. Directionality pattern is computed for 5 kHz and 10 kHz and the stability at the site is checked.

### Passive fathometry in shallow waters of Indian Continental shelf:

Cross correlating ambient noise received from a vertical array of receivers can be used for estimating the ocean depth, and the technique is known as “passive fathometry”. Passive fathometry technique has been applied to ambient noise data collected from shallow water locations. Both conventional and adaptive processing (MVDR) technique has been used to estimate ocean depth from ambient noise. Even though the adaptive technique provides better results, in certain cases error may occur in the estimation of fathometer response due to the sensitivity to random errors. The adaptive method needs inversion of CSDM, and if the matrix is not full rank, error may occur in the passive fathometer response. In order to get a better response using the MVDR inversion of the CSDM requires diagonal loading for stability which is equal to adding white noise to the CSDM. The response by adding white noise gain to the CSDM is shown in the following figure.



*Inverted seabed parameters for a silty and a sandy site*



*Comparison of MVDR and MVDR (White noise gain) beamforming for the same CSDM from Cuddalore.*

### **Development of vector sensor array for Underwater Source localization and signal estimation.**

A vector sensor is a passive acoustic device used for the detection and localization of acoustic sources. An Inertial type three element vector sensor array for a frequency range 10Hz to 6kHz was designed, developed and tested by NIOT in collaboration with M/s. Keltron Electro Ceramics, Kerala. The vector sensor array was tested at Acoustic Test Facility (ATF) of NIOT and further at Underwater Acoustic Research Facility (UARF), Idukki.

#### **Specifications of the 3-Element Vector Sensor Array (VSA):**

- 3-Inertial Type Vector sensors.
- Array is of length 1m, with separation of elements by 12.5cm
- Each sensor consists of a hydrophone, tri-axial accelerometer and a digital compass.
- Separate preamplifier for hydrophone and accelerometer is provided.

#### **Testing of vector sensor array in the field:**

The Vector sensor array was tested in the fishing harbor Chennai. The array was kept stationary in the seabed and the transmitter boat was moved to different locations. CTD



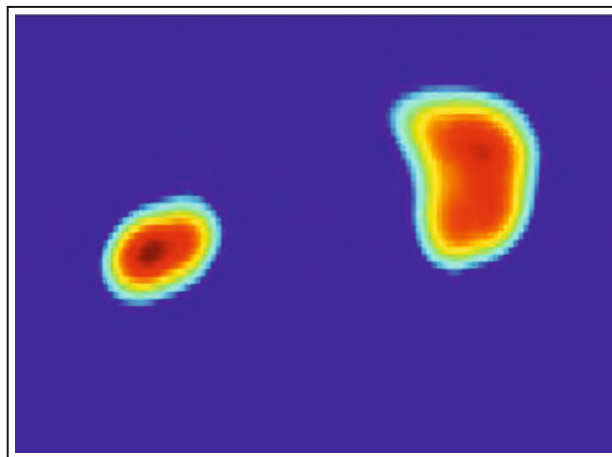
measurements were taken at each location. Test was conducted for a frequency range of 1 kHz to 6 kHz at source-transmitter distance ranging from 100m to 250m. All the voltage outputs from each vector sensor was connected to the pre-amplifier and then to the 24-channel high sampling data acquisition. The data were acquired for a period of 10 seconds at a sampling rate of 50k samples/second. The Direction of Arrival (DoA) estimation showed very good results.



*VSA at Jetty Test*

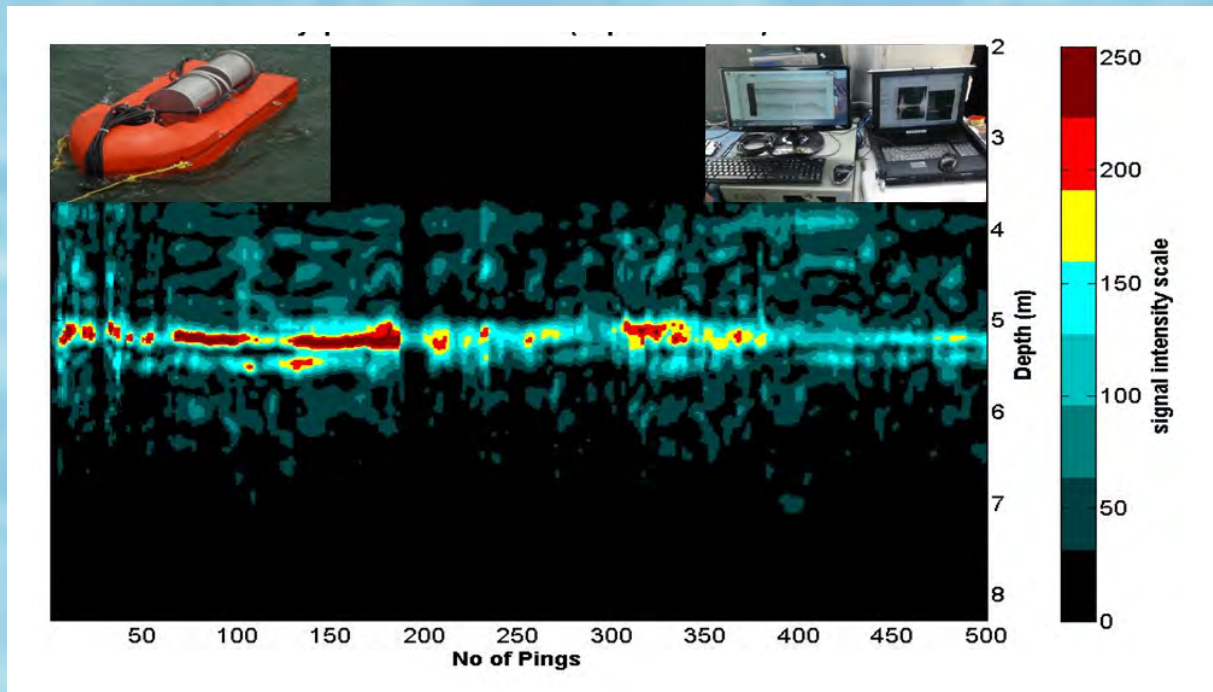


*VSA at Off Chennai*



*DOA at 73°Azi, 10°Elev, 5kHz, 110m*

## MARINE SENSOR SYSTEMS



*Underwater Buried Object Detection System*



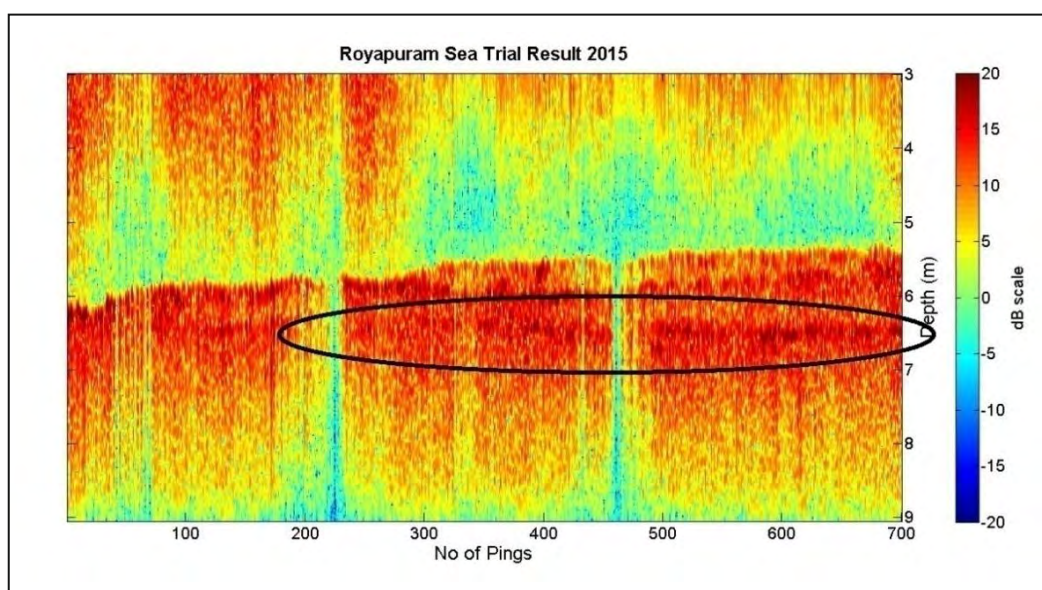
## MARINE SENSOR SYSTEMS

The objectives of the group is to develop sophisticated underwater sensor technologies and systems for marine applications, to establish a facility of excellence in order to provide electronic support for the various activities and projects of NIOT and to create infrastructure for reducing the development time and facilitate rapid prototyping.

### **Development of Buried Object Scanning/detection Sonar (BOSS) - Further improvements**

The group had indigenously developed a Buried Object Scanning Sonar (BOSS) and done several sea trials successfully to detect objects buried in sea bed. This system has been further enhanced with a 31 channel planar hydrophone array compared to the earlier 16 channels. The Lab view code has been modified to acquire and stream 31 channels data from the planar array. MATLAB code has been modified for reception of the streamed data and online processing. After the tests at Acoustic Test Facility (ATF), field trial was successfully carried out at Royapuram harbour, Off Chennai to test system performance in real time during April 2015.

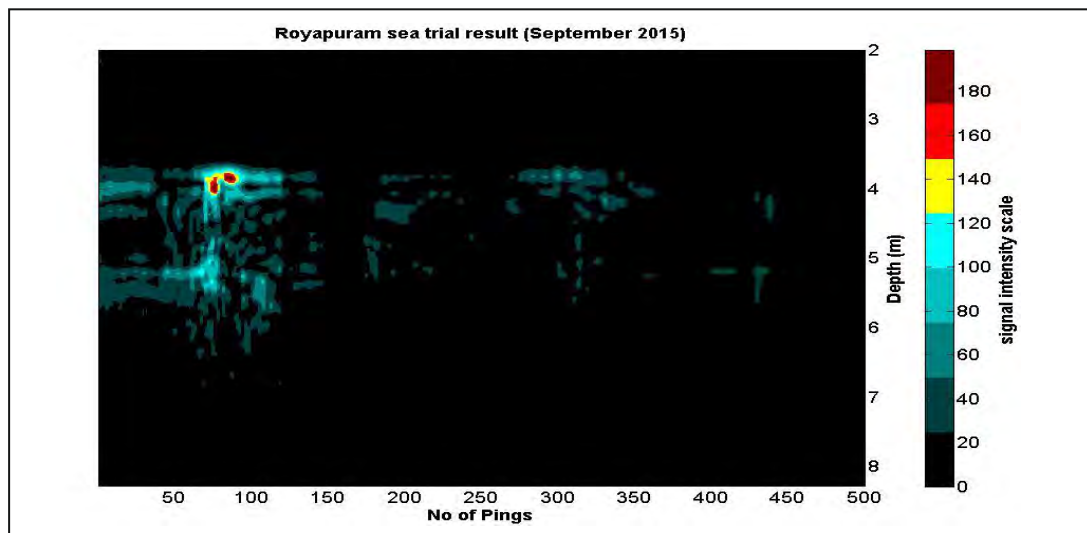
During the trial, presence of a second layer/debris in some places inside the harbour is found out and it is shown in the figure. The result throws light on the capability of the BOSS system as an Acoustic Sub-Bottom Profiler as well which, is promising as a spinoff of the BOSS project.



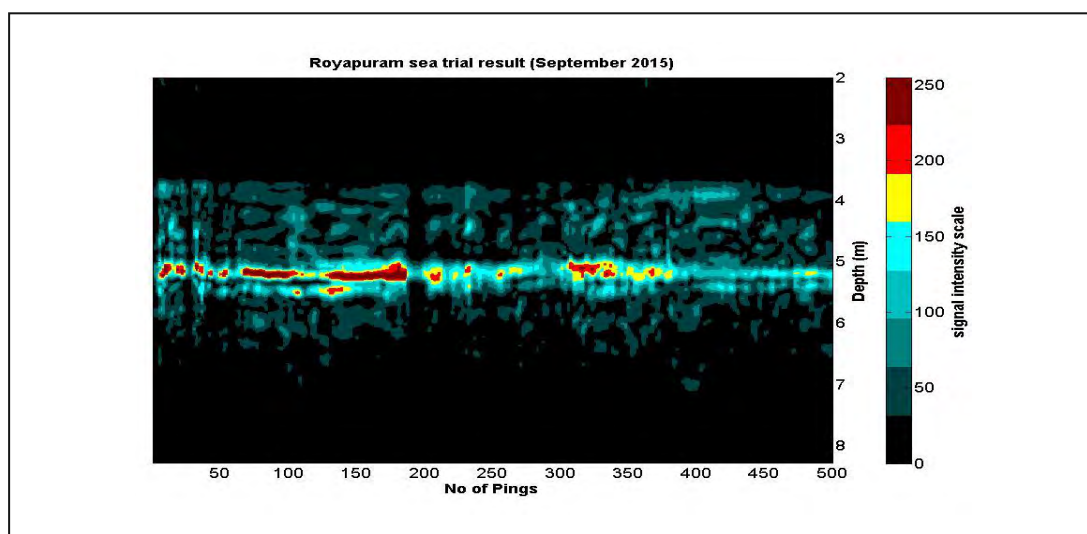
*Image showing the presence of second layer/debris*

### Sea trials:

In order to evaluate the BOSS system reliability and repeatability, a couple of further field trials were conducted during 14/09/15 to 16/09/15 at Royapuram harbor, Off Chennai. Compared to the previous field trials, on line packet loss correction was implemented in the code and tested during the trials. Number of pings was increased from 4 pings/s to 8 pings/s. Tow body was towed at 1-2 knots over the object and the image generated is shown in the figure. The frequency of operation was 2-16 kHz. The image shows the buried metal plate (1m x 1mx0.01m) which was detected when the tow body was towed at 1-2 knots speed. At some locations, presence of additional layers/ layers of unknown objects was also detected as shown in the figure.



*Metal plate detected at 1-2 knots tow speed (Sep 2015)*



*Additional layer/unknown objects identified at the site (Sep 2015)*





### **Development of BOSS stand-alone system**

In order to develop the stand alone BOSS system, sub systems assembly plan in the tow body has been finalized and heat transfer analysis of the electronic enclosure in the tow body also carried out. The enclosure has been designed and the assembly plan is in such a way that it can transfer theoretically 186 W, which is well above the generated heat of 125 W by the sub system.

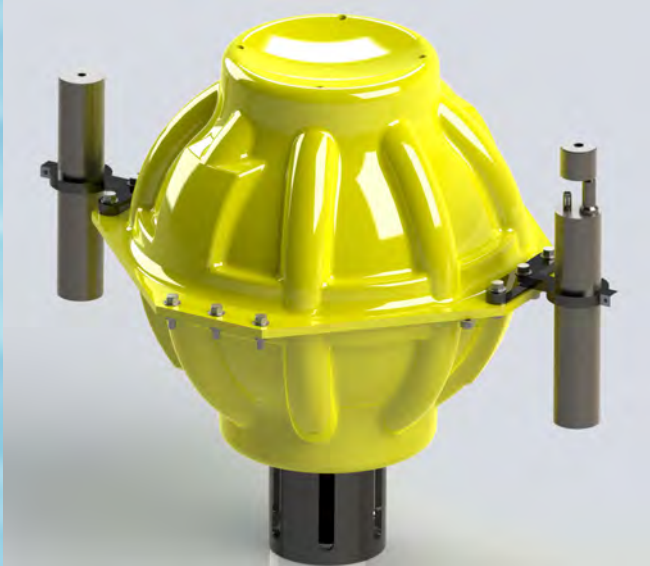
### **Revival of BOSS sub systems and lab equipment after flood**

Most of the sub systems of BOSS were inundated during flood. However, power amplifiers, AC-DC Converter, DC-DC Converters, power supplies, etc. of the BOSS system have been revived successfully for operation. The entire BOSS system after the revival has been successfully tested in ATF.

### **Utilization of Electronic Support Facilities**

All the commissioned facilities like environmental chamber, shock and vibration test facility were effectively used for quality control tests of subsystems developed by groups of NIOT, viza viz Deep sea technologies for prestigious projects like PROVe etc. These facilities were inundated during flood and the environmental chamber has been retrieved within two weeks and utilized for the revival of many flood affected electronic equipment's at NIOT.

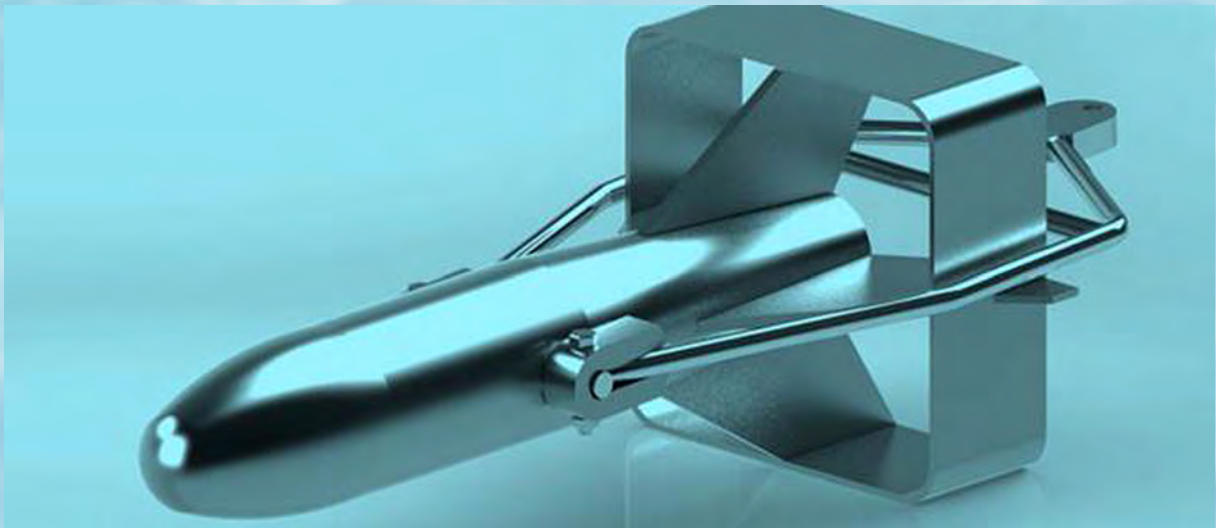
## OCEAN ELECTRONICS



*Deep sea AUPD*



*Drifter buoy*



*Solid Modelling of Tow fish*



## OCEAN ELECTRONICS

Ocean Electronics group has a mandate to develop and demonstrate autonomous ocean observation systems for various oceanographic applications. Presently the group is involved in the development of Autonomous Underwater Profiling Drifter (AUPD), Drifter buoys, Acoustic Modem, Deep Ocean Bottom Pressure Recorder (DOPR), Automatic Sub-Surface Floating Fish cage, 'C' Profiler etc.

### Autonomous Underwater Profiling Drifter (AUPD)

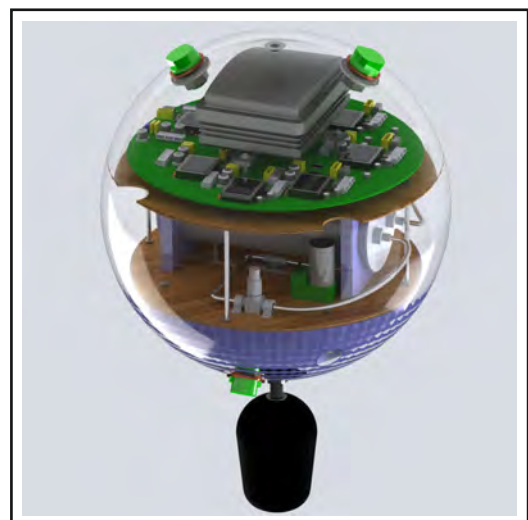
NIOT has successfully completed indigenization of Autonomous Underwater profiling Drifter (AUPD) Technology and the technology was transferred to Indian industry for trial production. 4 AUPD floats were deployed in Arabian Sea.



*Trajectories of 2 AUPDs*

### Deep-sea Autonomous Underwater Profiling Drifter (DAUPD)

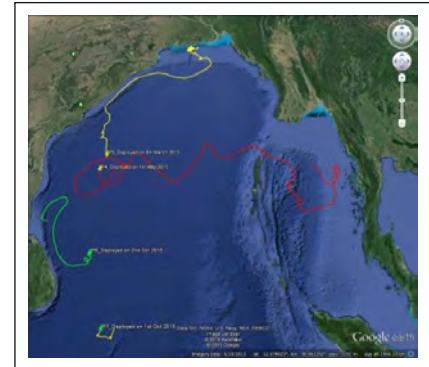
Deep Sea Autonomous Underwater Profiling Drifter (AUPD) for deep ocean exploration with Variable 1000CC Buoyancy Engine is under development. These floats drift freely at a predetermined depth, then periodically ascend to the sea surface, report to an orbiting satellite and descend again back to their parking depth for the next cycle. The first prototype system for 500m operation depth is being fabricated and the subsystems are under testing.



*Deep sea AUPD with internal assembly*

## Pradyu – Development of Drifter Buoy with INSAT Communication

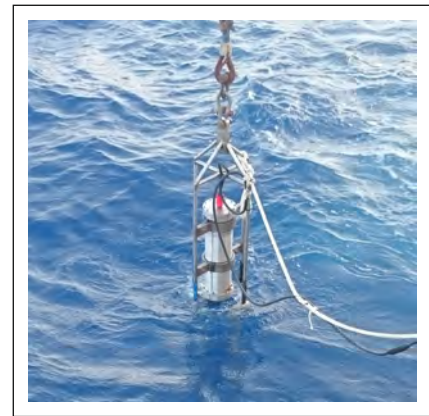
NIOT has successfully completed indigenization of drifting buoys with INSAT communication and the technology is transferred to Indian industry for trial production. In-house developed 7 drifter buoys were deployed in Indian waters. Trial production of Drifter buoys by 2 Indian industries is completed and 3 industry delivered systems are deployed.



*Trajectories of drifting buoys*

## Acoustic Modem for Underwater Communication

Orthogonal Frequency Division Multiplexing (OFDM) based communication scheme has been developed and proto type fabrication of acoustic modem for operating depth up to 1000m is completed. Sea trial conducted in Bay of Bengal and communication tested up to 670m. The system is further enhanced to address the problem due to Doppler shift and the data rate of the communication system is enhanced using advanced coding technique.



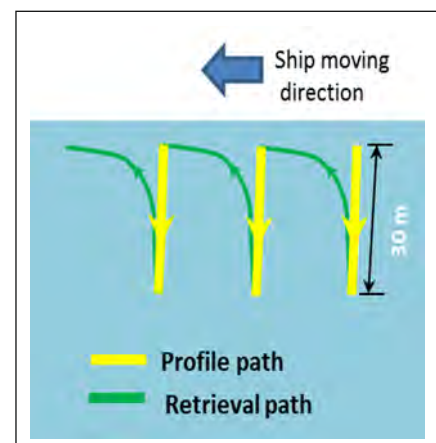
*Acoustic Modem – Sea Trial*

## Tsunami Detection System

Second proto type of Bottom Pressure Recorder (BPR) for detection of Tsunami in deep sea with modified scheme was deployed in Bay of Bengal at a depth of 3452m during December, 2014 and retrieved during April, 2015. Evaluation of the system performance is in process.

## 'C' Profiler

The group is involved in the development of 'C' Profiler to measure real time CTD parameters from a moving vessel at slow speed for addressing the recent need for the study of freshwater mixing in shallow water regions. The profiler aids real-time in-situ oceanographic data collection using a tow fish operated from a moving ship/boat in economical way, which will be one of its kinds in India. At present the tow fish payload is conductivity, temperature and depth (CTD) sensor which can be enhanced based on the requirement.



*'C' Profiler – System Overview*



### **AWS System**

The group is involved in installation of Autonomous Weather Stations in ships and for support of Ocean State Forecasting project of INCOIS. 5 ship based systems and 6 land based systems were installed and are working satisfactorily.



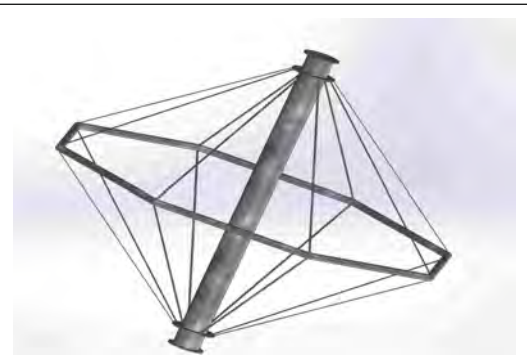
*AWS installations in Islands*

### **Automatic Sub-Surface Floating Fish Cage**

Open Fish cage used by Marine biotechnology group of NIOT for harvesting fish in coastal areas need to submerge to the depth of 10-15m during bad weather conditions and ascends to sea surface again during normal weather condition. The group is involved in developing Automatic Submersible Fish Cage along with MBT Group by changing buoyancy of the cage. Prototype testing was carried out in sea. Design and fabrication of octagonal cage is in process.



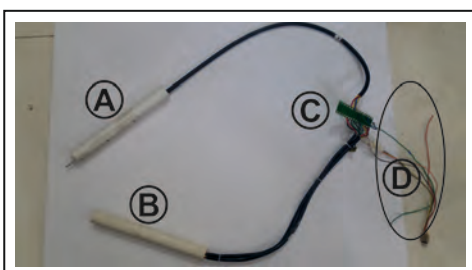
*Cage Assembly and test*



*Octagonal fish cage*

### **Wireless Expendable Temperature Profiler**

Inorder to make upper ocean thermal profile observations and to provide appropriate in situ data for testing ocean-atmosphere models, the group is involved in the development of Wireless Expendable Temperature Profiler. This compact unit measures sea water temperature up to 500m depth and transmits wirelessly avoiding the use of wire rope and winch for such measurements.



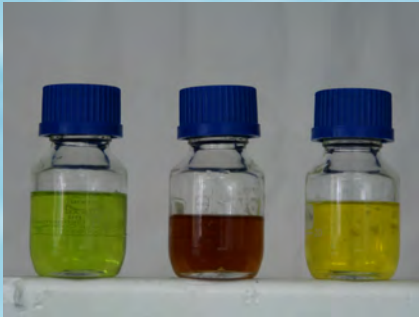
*CTS Sensor*



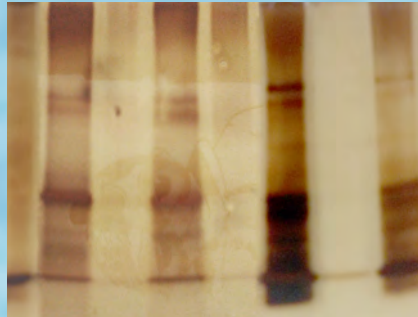
*Pressure Sensor*



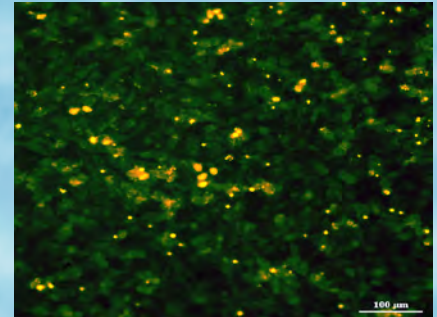
## OCEAN SCIENCE AND TECHNOLOGY FOR ISLANDS



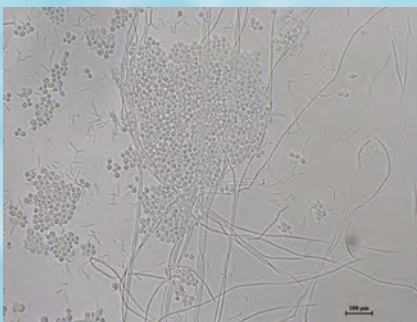
***Lutein Purification  
by preparatory HPLC***



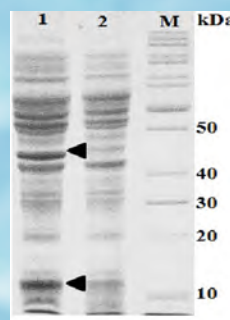
***Protein profile in Chlorella  
Growth Factor***



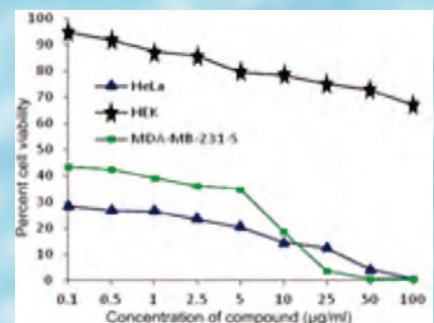
***Anti-proliferative effect of  
CGF in cancer cell***



***Hyphal form of the fungal  
pathogen Candida albicans***



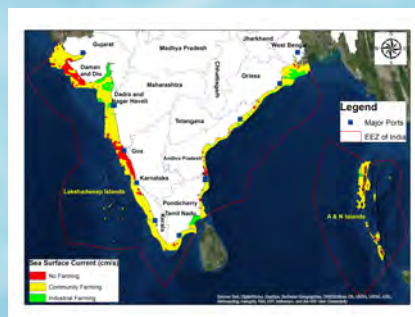
***SDS-PAGE of ectB  
and ectC of B. clausii.***



***Anticancer activity  
of S.fenghuangensis extract***



***Preparation of cage  
mooring grid at Tuplipalem***



***Sea surface current  
suitable for cage culture***



***Open Sea Cages  
deployed at Tuplipalem***



## OCEAN SCIENCE AND TECHNOLOGY FOR ISLANDS

Ocean Science and Technology for Islands (OSTI) is primarily focusing on three major activities viz. Marine Algal Biotechnology, Marine Microbial Biotechnology and Open Sea Cage Culture with following objectives:

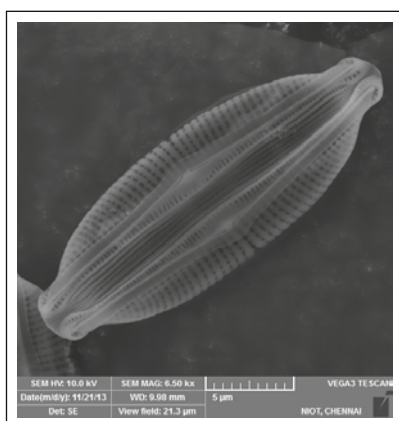
- Development of mass scale harvesting, dewatering and extraction techniques for the production of nutraceuticals.
- Extraction, purification and characterization of novel secondary metabolites from marine microbes including deep sea microbes for environmental and biomedical applications.
- Design, development and testing of sea cages suitable for Indian seas, and demonstration of marine finfish farming in open sea cages.

### Microalgal biotechnology

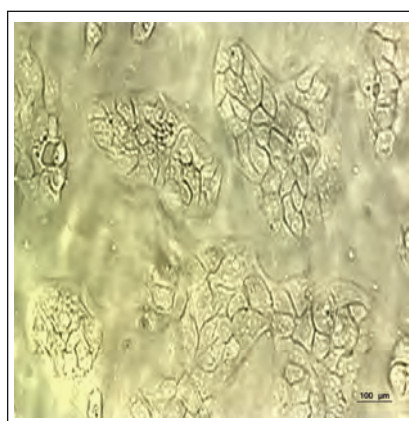
The microalgal research at NIOT was focused on the production of high value pigments, nutraceuticals, Chlorella growth factor, bioactive compounds, biolipids, strain improvement and biofuel production. Towards simultaneous recovery of lutein and lipid, using different bi-phasic solvent systems, ethanol:hexane (1:1) yielded the maximum lutein recovery (93.34%), while maximum lipid recovery was obtained with DCM : ethanol solvent system (86.35%). Further, simultaneous saponification with tetrahydrofuran gave maximum lutein yield of 11.51 mg/g. Development of high nutraceutical producing hybrid was attempted by protoplast fusion method with *Arthrospira platensis* and *Synechococcus marina*. Maximum biomass of  $3.20 \pm 0.10$  g/L was observed in hybrid ACDR-13, which was 1.57 fold higher than the parent 1 (*A. platensis*) and 2.82 fold higher than parent 2 (*S. marina*). Hybrid ACDR-11 exhibited the maximum zeaxanthin production ( $25.32 \pm 1.32$  mg/L) and c-phyococyanin productivity ( $386.14 \pm 13.72$  mg/ L). The zeaxanthin obtained in hybrid ACDR-11 was 3.1 fold higher than parent 1 (*A. platensis*) and 10 fold higher than parent 2 (*S. marina*). The c-phyococyanin obtained in hybrid ACDR-11 was 1.64 fold higher than parent 1 (*A. platensis*  $234.60 \pm 12.56$  mg/L) and 7.04 fold higher than parent 2 (*S. marina*  $54.83 \pm 1.73$  mg/L). Optimization of medium constituents has also been carried out successfully using Central Composite Design (CCD) for enhancing zeaxanthin and C-phyococyanin production.

Chlorella Growth Factor (CGF) extracted from the wet biomass of marine microalgae, *Chlorella vulgaris*, using hot water treatment. The hot water extract also possessed biopharmacological efficacy such as lowering of glucose absorption by inhibiting the activity of enzymes such as  $\alpha$ -glucosidase and  $\alpha$ -amylase, which plays an imperative role in Type II Diabetes Mellitus. CGF extract also exhibited anti-inflammatory activity by reducing the inflammation associated apoptosis compared to the standard anti-inflammatory drug, Methotrexate.

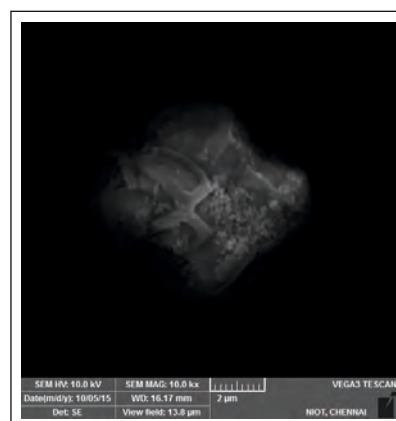
A pennate diatom *Amphiprora paludosa* (AT-49) was isolated from Andaman coast and growth medium was optimized by Central Composite Design and maximum fucoxanthin production of 14.1 mg/g dry biomass was achieved. In continuation to the testing of biodiesel for chemical parameters and engine performance, the storage stability was assessed for the B-10 and B-100 biodiesel by using ASTM D4625. The results confirmed that except kinematic viscosity, all the other parameters remained unchanged between B-10 and B-100 biodiesel.



*Amphiprora paludosa*  
(AT-49)



Anti-inflammatory effect of  
CGF extract



Hybrid *A. platensis* and  
*S. marine*

### Microbial biotechnology

New actinomycete *Streptomyces* sp. NIOT isolated from 2000m deep sea sediments was found to produce multiple prodiginines, a family of tripyrrole compounds. Five analogs of antibiotic prodigiosin were identified and characterized and one fraction was found to be active against Methicillin-resistant *Staphylococcus aureus* (MRSA). Sesquiterpenes and ascotricins were also extracted from the deep sea fungus *Ascotricha* sp. isolated from 1700 m depth.

Functional characterization and in silico sequence analysis of ectoine biosynthesis genes was carried out from deep sea halotolerant bacteria, *Bacillus clausii*. The ectoine synthase activity of the expressed cells was 6.5 mU/mg. The lysates of induced cells showed two clear expressed bands with molecular masses of 45 kDa and 14 kDa that correspond to ectB and C, which was not present in non-induced cells. The expressed protein band of ectA gene was not detectable in SDS-PAGE. The phylogenetic tree at nucleotide and amino acid level of ectA revealed the phylogenetic similarity of ectA genes from *B. clausii* with other organisms. *B. clausii*, *M. halophilus* and *B. alcalophilus* was grouped in the same cluster in both the phylogenetic trees. Secondary structure prediction result also revealed considerable similarity with the reported ectoine biosynthesis enzymes from eubacteria. Three dimensional structure prediction of the ectoine synthase enzyme was validated using Ramachandran plot and the plot suggested that none of the residues were present in



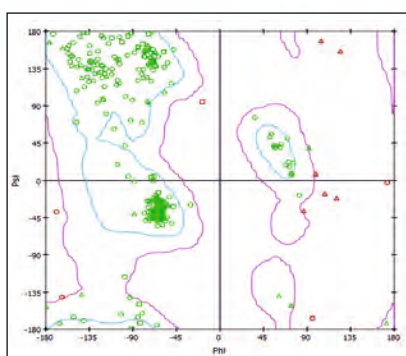
the disallowed region. This deduces that the modelled structure shares high level of similarity with the structures that have been already reported. Homology analysis of ectoine synthase enzyme with Protein Data Base (PDB) revealed the maximum of 100% and minimum of 21% identity with the PDB templates. These results suggest the active domains of ectoine synthase from *B. clausii* have considerable identity with the database reports.

Production optimization and biochemical characterization of recombinant ectoine was studied with the recombinant host, *E. coli* M15 (pREP4). The production of ectoine was found to be maximum with 1.5 mM IPTG, pH 7.5, 1.5% NaCl concentration, 1% glucose and 1% yeast extract concentration. The HPLC analysis of the ectoine also revealed the appearance of additional peaks in the test samples, which was not seen in the control samples. The concentration of ectoine was 6.6 mg/l of expressed cells. NMR measurement also revealed that the protons peaks corresponding to recombinant ectoineas observed in the cellular extracts induced with 2.0 mM IPTG and as illustrated by their chemical shift values. The intensity and peak size of recombinant ectoine was found increasing, suggesting that ectoine is produced in an IPTG-dependent manner.

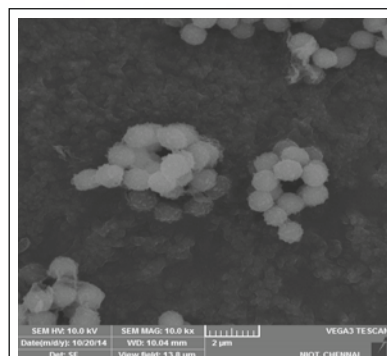
Purification of recombinant L-asparaginase was carried out by Ni-NTA column and HPLC. Biochemical analysis of recombinant L-asparaginase was undertaken using NMR, MALDI-TOF and GC-MS. Structural modeling and molecular docking studies on L-asparaginase was performed with the ansA proteins in Protein Data Base (PDB). Maximum of 43% identity and minimum of 15% identity was observed in ansA protein of *Nocardia alba* NIOT. The structure was validated using Ramachandran Plot, which suggested that around 85% of the amino acid residues were present in the favorable region. The molecular formula of the L-asparaginase from the *N. alba* NIOT is  $C_{1477} H_{2381} N_{432} O_{440} S_{11}$ . The CDocker binding energy of the recombinant L-asparaginase was found to be -28.7542 Kcal/mol. Recombinant L-asparaginase was found to have high cytotoxic activity towards JURKAT cells (acute lymphoblastic leukemia) than other cell lines.



*3-Dimensional structural analysis of recombinant L-asparaginase*



*Ramachandran plot  
analysis of recombinant L-asparaginase*



*Streptomyces  
fenghuangensis-SEM*

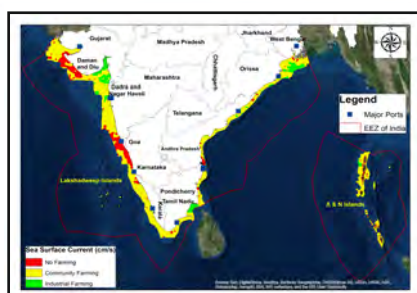
### Open sea cage culture:

A weighted overlay analysis was employed to map potential cage farming/mariculture sites across the Exclusive Economic Zone of India. The analysis identified a vast sea space technically suitable for sea farming between 5 and 100 m depth zone. This technical suitability was proposed based on 10 crucial parameters: a) depth, b) sea surface current (SSC), c) significant wave height (SWH), d) total suspended matter (TSM), e) sea surface temperature (SST), f) salinity, g) dissolved oxygen (DO) h) chlorophyll-'a', i) nitrate and j) phosphate. Further the analysis identified the availability of around 3,01,707 km<sup>2</sup> suitable area for mariculture including Islands which accounts for 14.9% of the total EEZ of the country. Interestingly, most of these identified sites falls within 46.3 km range from existing sea ports which is lauded (World Port Index, 2009) as cost effective area universally. The coastal waters were further classified into three zones: a) no farming (0-5 m depth), community farming (5-20 m depth) for small scale low intensity farming and an industrial farming (20-100 m depth). Considering the huge desirable areas available for sea farming, a comprehensive plan to initiate an environmentally responsible farming to the tune of 1 mmt pilot production was proposed to the Ministry of Earth Sciences (MoES) to increase the sea food availability and thereby ensuring the nutritional requirements of the country.

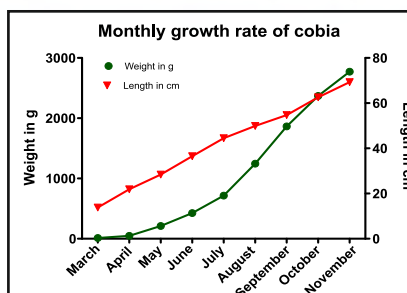
### State-wise area availability for mariculture based on the overlay and clipping analysis

States	No Farming	Community Farming	Industrial Farming	Total Area (km <sup>2</sup> )
Goa	97	899	6353	7349
Andhra Pradesh	741	8443	17848	27031
Gujarat, Daman & Diu	4301	18685	52498	75483
Karnataka	244	2416	14632	17292
Kerala	436	4337	30950	35723
Maharashtra	1264	6404	41116	48784
Odisha	3039	13519	19450	36007
Tamil Nadu & Puducherry	2360	12936	17918	33215
West Bengal	2249	1129	-	3378
Lakshadweep	35	293	533	861
A & N Islands	466	4313	27037	31816
Total Area (km2)	15,230	73,373	2,28,334	3,16,937





Mariculture potential areas for offshore farming along the Indian coast



Growth rate of cobia cultured in Olaikuda



Cobia harvest at community based cage culture Olaikuda - November, 2015

### Development of advanced methods for biofouling control jointly with Water and Steam Chemistry Lab of BARC, Kalpakkam:

Towards development of advanced methods for biofouling control, NIOT has successfully designed and developed a low cost high voltage pulse system (HVPS) to control the biofilm formation in the marine environment. When tested against the model test organism, the biofilm-forming bacterium *Oceanimonas smirnovii* (NIOT-bflm-S10), the impact of HVPS was found to increase with increase in pulse modules. The relative tolerance of cyprids of the major fouling barnacle, *Amphibalanus reticulatus* to thermal stress was assessed, wherein 65% mortality was observed at 40°C. The percentage of cypris attached and metamorphosed decreased with increasing temperatures, with less than 5% being able to settle at 40°C. Under dynamic conditions also the cypris mortality increased with increasing temperatures (82% at 40°C). 100% inhibition of *A. reticulatus* settlement was observed on CuO PDMS nano composites. Surface modification approach for preventing settlement of barnacle *A. reticulatus* larvae using organosilanes showed high variability and dependence of wettability in larval settlement, with the least settlement (10%) observed on ATS (Allyl Trimethoxy Silane). The passive and combined antifouling strategy for ultrafiltration membrane revealed that both the test and control membrane foul equally and in the same manner by forming a gel layer on the membrane. In test membrane upon backwash the parameters like flux, TMP, reject water flow rate indicating that the membrane regains its original flux compared to the control.

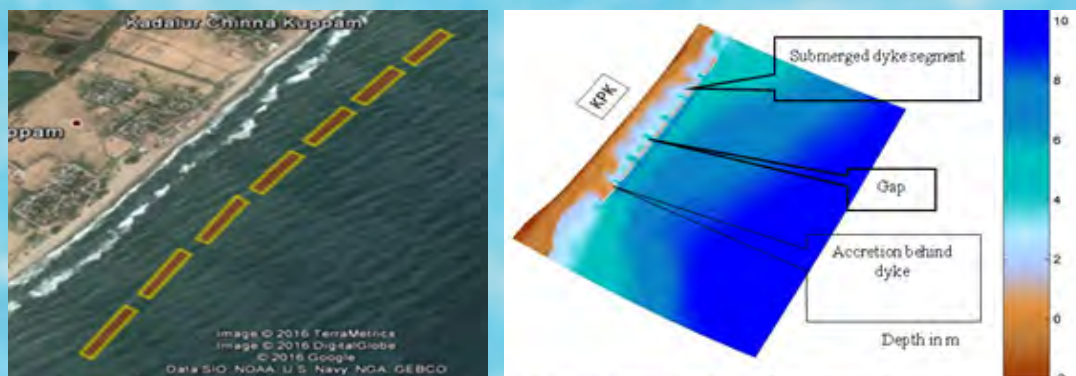
Towards monitoring the ecotoxicological effects of antifouling chemicals, mussel transplantation studies in an operating power plant was undertaken using multiple biomarker approach. It was observed that the Condition Index (CI) of the mussels decreased after a week of transplantation in chlorinated environment in comparison with control, indicating weakening health of the mussels in chlorinated environment. The assessment of Super Oxide Dismutase (SOD) enzyme in the phytoplankton model, *Chaetoceros lorenzianus* indicated increase in SOD with increase in chlorine concentration, necessitating further studies in this direction.



## COASTAL AND ENVIRONMENTAL ENGINEERING



***Shoreline change - Impact of Erosion***



***Layout of Proposed Solution***

***Numerical Model***



***Filling of geo-synthetic tubes at site***



## COASTAL AND ENVIRONMENTAL ENGINEERING

Coastal and Environmental Engineering group works with a mandate to enhance existing scientific knowledge on coastal processes, and their interaction with other spheres of earth. The development process integrates field observations with state of the art equipment, mathematical analysis, and design of models to develop concepts of sustainable engineering intervention.

The major projects taken up by group are

### A. Shoreline Management

- a) Audit of Shorelines for assessing performance of coastal protection measures
- b) Demonstration of environmental friendly shore protection works
- c) Development of scientific knowledge on Coastal and Estuarine Dynamics
- d) Evaluation of erosion and protection measures for potential sites

### B. Technical Criteria Atlas

### C. Operation of HF Radar network along the Indian coast under Ocean Observation Network

### D. Hydrodynamic and sediment model studies for Gulf of Khambhat

### E. Engineering and environmental consultancy work to cater to nation building exercise.

## Shoreline Management

### Audit of Shorelines under sustainable shore line management programme

The objective of the study is to map the presence of various shore protection structures along the coast and measuring their physical and ecological impacts on the coast thereby auditing their performance. An audit of shore protection schemes for evaluating the performance of various shore protection measures along the coast of Tamil Nadu was extensively carried out.

Audit of shorelines has been completed for 6 of 13 coastal districts and works for the remaining are in progress. The coast of Tamil Nadu has been divided into 7 zones based on orientation, type of coast, morphology and geological phenomenon.

Data collected from field investigations and secondary sources forms the basis for “Digital maps”, which will provide information on shoreline changes due to shore protection schemes at site and other manmade structures along the coast, wave data; sedimentology etc. Data for zone 7 is available for visualization.

Based on the audit, a long term monitoring of shoreline is being carried out from Tuticorin to Poovar. The work involves data collection for cross shore profiles, Littoral Environmental Observation (LEO), grab samples, sediment cores etc.



*Various zones of Tamil Nadu coast for Digital Maps*

Similar work is undertaken along Visakhapatnam coast with emphasis on Ramakrishna beach and surroundings. Evaluation of long term statistics of the shore line and its annual variability using remote sensing techniques is the objective of the project.

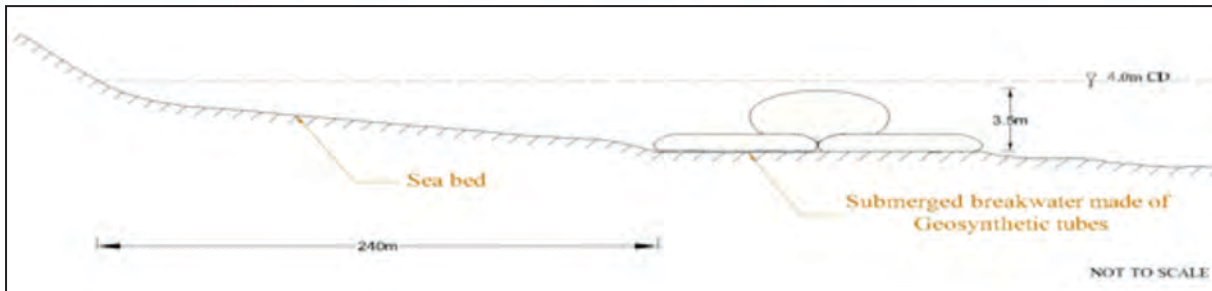
### **Demonstration of environmentally friendly shore protection works**

Demonstration of environmentally friendly coastal protection measure is being undertaken at Kadalur Periyakuppam (KPK), Tamil Nadu. Numerical modelling using DELFT 3D was carried out and submerged dyke was proposed as a sustainable solution for creation of salient and preventing erosion. The final configuration consisted of a segmented submerged dyke consisting of 200m long segments with gaps of 60m in between them. The height of dyke will be 3.5 m in 4 m water depths. A total of 7 segments covering a length of 1.76 km including gaps covering all the fishing villages are proposed.

Present status of demonstration of shore protection:

- Geo-synthetic tubes for construction of submerged dyke were procured.
- Pre-construction works including field data collection and vibrocoreing and preliminary dyke installation experiments are in progress





*Typical Section of submerged breakwater at Kadalur Periyakuppam*



*Installation of geosynthetic tube for submerged breakwater at Kadalur Periya Kuppam*

## **Development of scientific knowledge on Coastal and Estuarine Dynamics under Sustainable Shoreline Management**

### ***The Long term study of the Coastal Acidification along the Coast of the Gulf of Mannar (GoM) and Palk Bay, South East Coast of India.***

The program was taken up with an objective to monitor the Spatial, Seasonal variation of the pH, Salinity, Dissolved Oxygen, Carbon dioxide, Calcium Carbonate saturation ( $\Omega$ ) and Dissolved Inorganic Carbon (DIC) profiling in the coastal water of the Gulf of Mannar, Palk bay.

Field data collection was carried out from September 2014 to March 2016 to cover various seasons. The calcium carbonate saturation and physico-chemical characteristics of coastal water of GoM is being analyzed. The study is taken up in consultation with Forest Department to satiate the restrictions by Marine Protected Area (MPA) of the Gulf of Mannar Marine National Park that includes Coral reef areas and 21 minor Islands.

Spatial variation of temperature, salinity, Dissolved Oxygen, Conductivity, pH and other parameters analyzed from field data show significant spatial variation of carbonate and bicarbonate concentration have shown significant spatial variation which could be due to human exploitation and CO<sub>2</sub> flux.

### **Water quality monitoring at selected Estuaries and coastal sites of the Gulf of Khambhat (GoK).**

The major aim of the study is to determine salinity flux and physico-chemical variation in the coastal waters and major estuaries of the Gulf of Khambhat. The surface water and sediments were collected at estuarine and coastal locations in the Gulf of Khambhat (GoK) and five estuaries (Tapi, Narmada, Dadar, Mahi and Sabarmati) covering low and high tides with seasonally starting from January 2015 to December 2015 for various seasons.

### **Study of ecological impacts of coastal protection measures**

Studies were carried out to map the accumulation / occurrence of biota on the components of the coastal protection structures installed along the coast of Tamil Nadu.

The process of ecological succession has been established through epibiota population density assessment along Tamil Nadu coast for a year period. The presence of alien gastropod from Caribbean coast harbored at breakwaters of Chennai fishing harbor is established. Apart from these 4 more organisms were found to be nonindigenous, suggesting that these structures could be hot spots for harboring alien species.

Studies have also been undertaken to assess the formation / development of epibiota on test geo-synthetic bags that are being installed for coastal protection. There is significant growth of epibiota which is likely to change the performance of the geosynthetic as related to slight increase of tensile strength by preventing decay due to UV radiation from sun light.

### **Evaluation of erosion and protection measures for Visakhapatnam**

Erosion has been observed along North Andhra Pradesh and Odisha coasts following cyclones Phailin and Hudhud. The Ramakrishna beach front of Visakhapatnam is found to have scarcity of sediments. Greater Vishakapatnam Municipal Corporation (GVMC) requested NIOT to undertake studies and provide engineering mitigation measure for short term and long term stability of the coast.

Field data collection was taken up and studies using numerical models were carried out to assess the variability of oceanographic characteristics and their effect on the shoreline kinetics. Sand by passing and beach nourishment were suggested for long term stability of the coastline.



## **Technical Criteria Atlas**

### **Tide**

The plan project 'Technical Criteria Atlas' aims to provide ready reference for parameters like tide, wave and water level in terms of return period/extreme values required for preliminary planning, analysis and design of coastal infrastructures.

Regional models were setup for Bay of Bengal and Arabian Sea. Each Domain is sub divided into several high resolution models in the Gulfs, Viz., Gulf of Kutch, Gulf of Khambhat, Mumbai Creek on the west coast; Gulf of Mannar, coastal Tamil Nadu, Andhra Pradesh, Orissa, West Bengal and Ganges estuary with Sundarbans. The models are forced with TOPEX/Poseidon corrected tidal boundaries. Local bathymetry information from in house surveys, hydrographic charts and Global open data sets were utilized in the work.

Models at finer resolution for various tidal inlets viz., Mumbai Creek, Keri Estuary, Gulf of Mannar, Ennore creek and Mahanadi estuary are completed. Arabian Sea model was validated at 20 IHO stations and INCOIS tidal network. Bay of Bengal model is in the progress of calibration studies.

### **Storm Surge**

Calibrated tidal models were utilized to carry out storm induced surge simulations. Storm surge model was setup for the Arabian Sea and is coupled with spectral wave model. Simulations were carried for the storms passages for the period 1970-2015 for hindcast studies. Water level envelopes are being developed. A web map server (digital) was developed to display the estimated water envelopes for historic storms. The models are run in tandem with spectral wave models to evaluate the shallow water wave surge interaction.

Hind cast studies from 1970 to 2015 for Arabian Sea is in progress. Major cyclones of higher intensity were completed and utilized in Kalpasar studies. Similar strategy is being adopted for Bay of Bengal.

### **Wave**

Wave Atlas has been published for Indian coast. Updates with new wind data sets and simulations are being verified statistically against publication. Evaluation of the effect of surface piercing shoals and islands into the domain are being carried out.

### **Dissemination works**

Web portals have been developed to access information and results generated from TCA project components like wave statistics, near time and long term tidal predictions and storm surge simulations into a GIS platform.

Portals are available to access real time tide and meteorological parameters at various site, run at several ports and available coastal structures.



*Coastal Monitoring System*

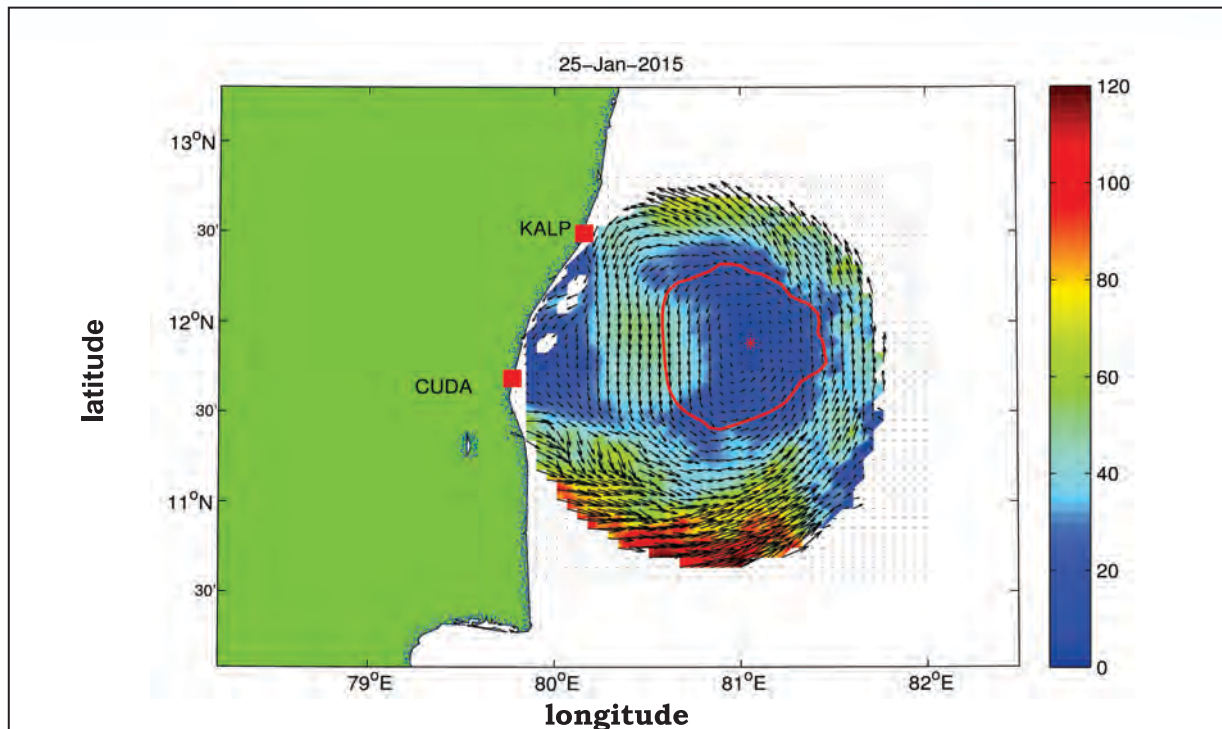
### **Operation of HF Radar network under Ocean Observation Network**

5 pairs of the High Frequency Radar's along the Indian Coast are being operated and the data is available to Scientific community through INCOIS. Cyclone observations including deep depressions during the year 2015 were reported. HF radar data is compared with the satellite derived OSCAR data, the analysis showed 66% correlation between v component data (North-south direction).

The East India Coastal Current reverses its direction twice a year and are subjected to small scale variability. The kinematics and dynamics of these variabilities are not well studied or documented along Indian coasts. In this regard High Frequency (HF) radar technology has been gaining recognition as an effective method of mapping ocean surface currents in the coastal zone up to a distance of 200 km.

Presence of mesoscale and sub-mesoscale eddies along Tamil Nadu coast were detected and tracked for the year 2015 with the help of HF radars systems located at Kalpakkam and Cuddalore.





*Meso scale eddies along Tamil Nadu coast*

### **Hydrodynamic and sediment model studies for Gulf of Khambhat, Kalpasar**

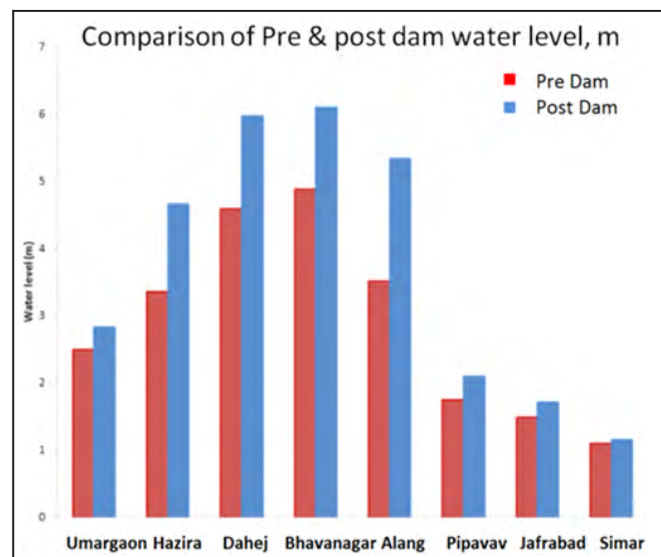
Kalpasar Project is a major civil engineering work envisaged to capture fresh water draining out from Mahi, Narmada and Sabarmati rivers by constructing an earthen dam across the Gulf of Khambhat extending from Bhavnagar to Dahej. Kalpasar department entrusted the seabed engineering investigations and numerical modeling work to NIOT.

Numerical model studies related to hydrodynamics, wave and sediment transport were carried out for Gulf of Khambhat to assess the impact of proposed dam on hydrodynamics and inundation. Hydrodynamic impact of proposed dam on either side of the dam is studied using numerical model studies.

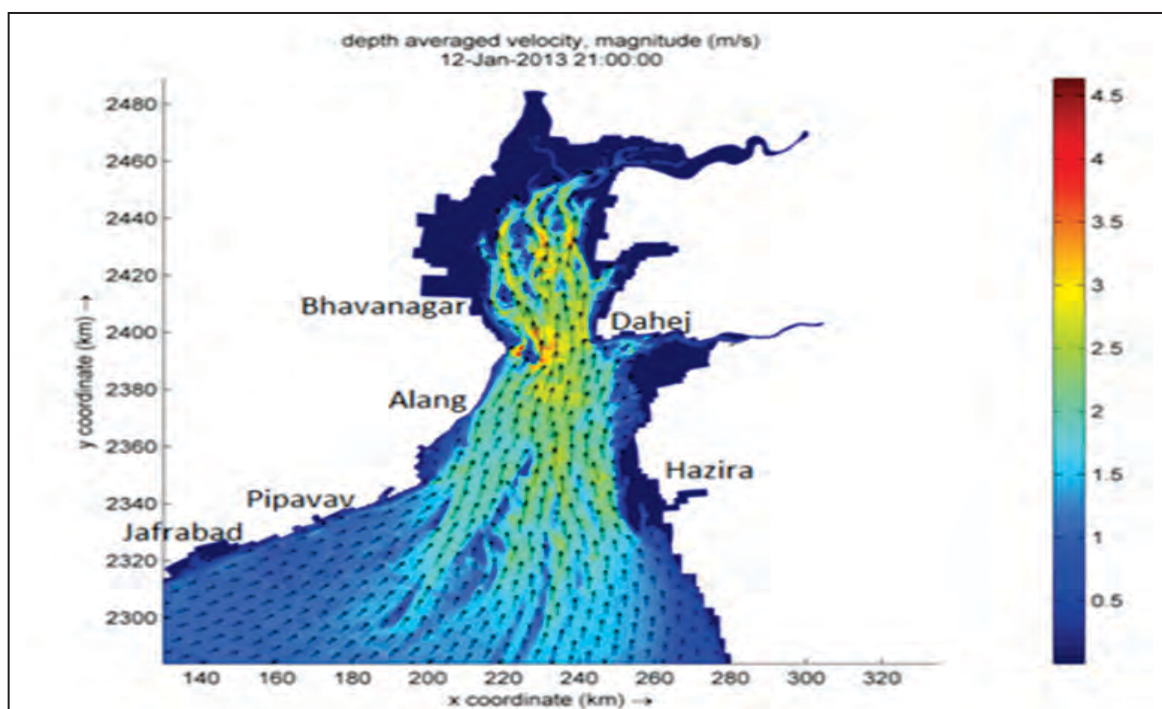
Model scenario such as dam construction, dam break, reservoir stratification and saline water evacuation with sluice gates were simulated. Dam cross section has been designed based on the design water level arrived from the model studies (hydrodynamic, wave and storm surge). NIOT is working closely with Design team of Kalpasar to evaluate the impact of the construction works.

Reservoir model studies were carried to study the saline water stratification in the reservoir and to assess the time required to convert the saline water in the reservoir to make potable water.

The hydraulic changes after dam construction and additional changes by Bhadbuth barrage were evaluated to assess the changes and protection works to be anticipated. NIOT has carried out the hydrodynamic setup at the dam location with earthen embankment in place with likely maximum intensity of episodic events for Arabian Sea and recommended the required Crest elevation.

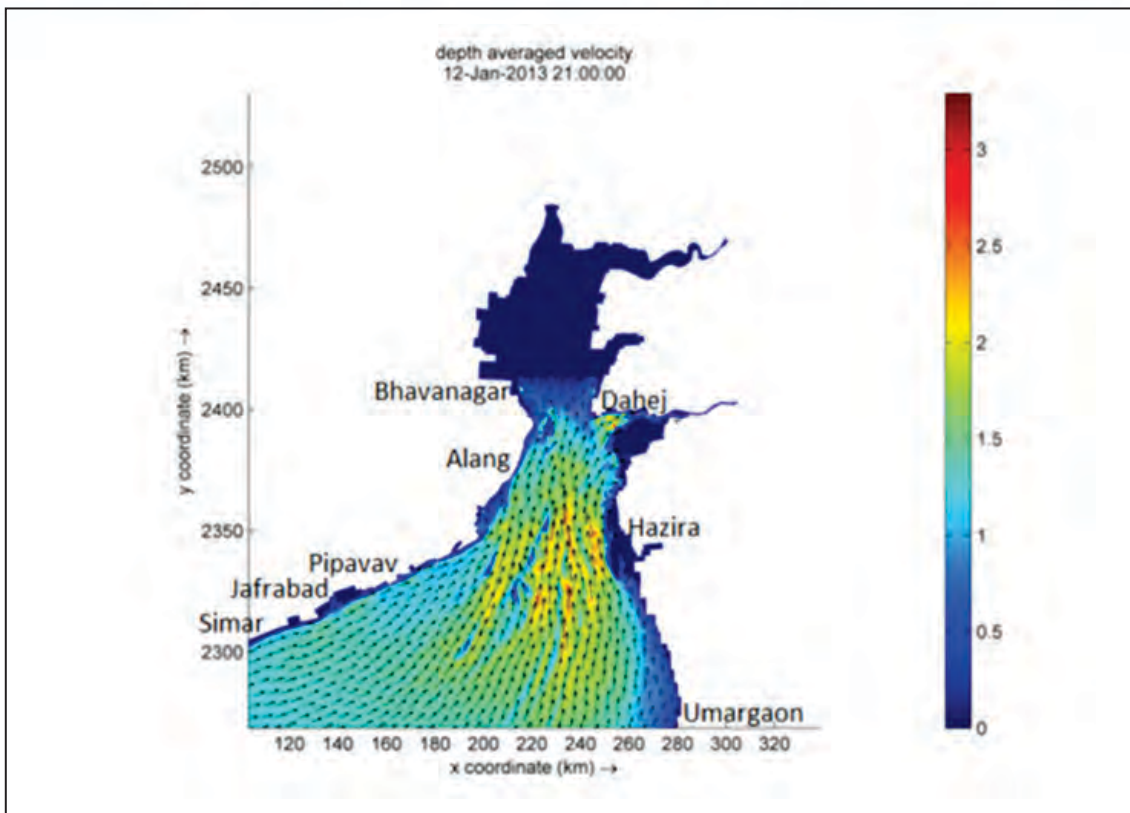


*Effect of proposed dam on water levels*



*Depth averaged velocities for pre dam*



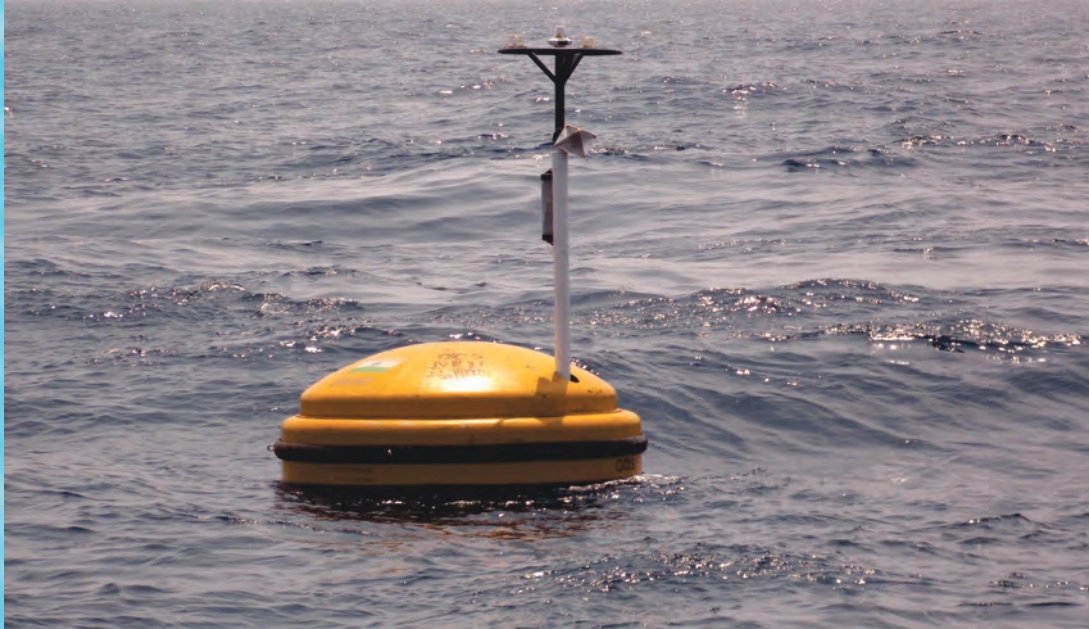


*Depth averaged velocities for post dam*

### **Engineering and environmental consultancy work to cater nation building exercise**

1. Manali Petrochemical Limited (MPL), Chennai, EIA - Studies were completed during April to June 2015.
2. Spit development assessment studies for Goa State Infrastructure Development Corporation Limited – studies on sediment transport and estuary hydraulics were taken upon request by National Green Tribunal.

## OCEAN OBSERVATION SYSTEMS



*Prototype Sagar Bhoomi System*



*Indarc-II Mooring Deployment & Configuration*



## OCEAN OBSERVATION SYSTEMS

The Ocean Observation Systems (OOS) group of NIOT has the mandate to establish and maintain moored buoy network in Indian Seas incorporating newer technologies for monitoring the marine environment and to improve weather and ocean forecasts. Considering the importance of continuous measurements of data of high reliability and quality, optimal numbers of buoys are maintained at strategic locations in the Bay of Bengal and Arabian Sea.

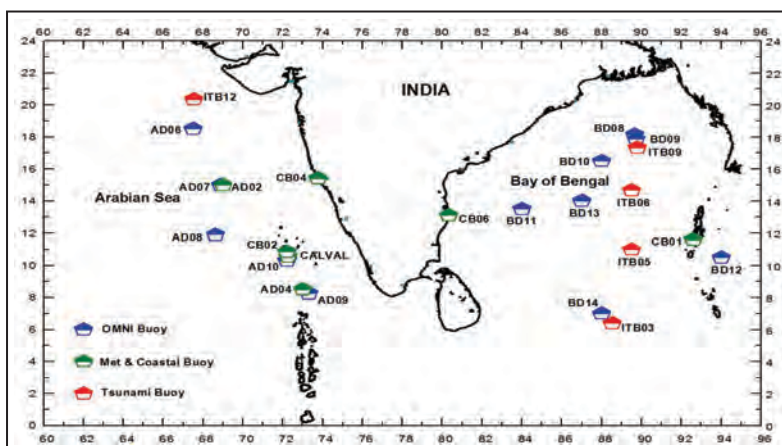
The components being executed by OOS are

- Moored Data Buoys - Met Ocean & Tsunami
- Phase II of CAL VAL buoy system
- Technology demonstration of new observation tools
- Inter-Institutional R&D projects (National & International)

During the reporting period, 67 deployments/retrievals were completed through 19 cruises. Altogether, these cruises lasted 260 ship days covering 22018 nautical miles with 1540 man-days. These buoy systems provide valuable data for scientific and oceanographic community.

### Deep Sea Instrumented Buoys

State-of-the-art next generation deep sea buoy systems are installed in 12 locations which are collecting and transmitting Meteorological, Oceanographic and subsurface parameters in real time to shore. In addition, four coastal buoys with INSAT & GPRS telemetry and Calibration and Validation, a buoy system to validate satellite data, are being deployed and maintained successfully. Under Tsunami Buoy Programme, five tsunami buoy systems are being maintained by NIOT. INCOIS is sharing Indian Tsunami buoy Data with NOAA-NDBC.



*Map showing locations of various moored buoys in the North Indian Ocean*

### Indigenous Buoy Data Acquisition System - Hrudya

As part of indigenous development seven variants of data loggers are working satisfactorily with data/tsunami buoy systems at various locations at Sea. Indigenous Buoy data Acquisition system-Hrudya collects and transmits 106 meteorological and oceanographic parameters in real time to Mission Control Center and also uses a low power processor with hybrid charge controller with facility to transmit data through Inmarsat, INSAT, GPRS and UHF telemetry.

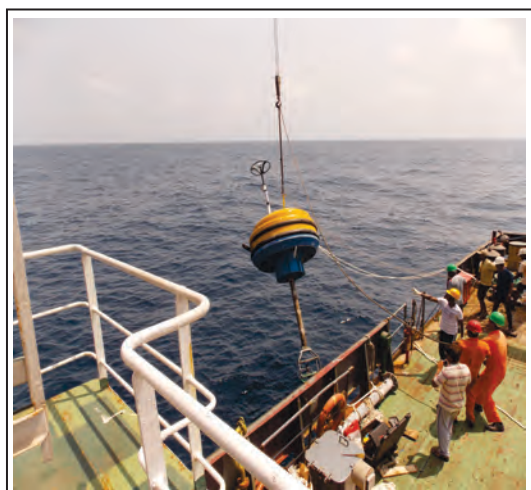


*Coastal buoy with GPRS telemetry*

### Indian Tsunami Buoy System (ITBS)- 'Sagar Bhoomi':

Indian Tsunami Buoy System (ITBS) development includes next Generation buoy hull, Low Power Integrated Data Acquisition Module (LIDS) and Indigenized BPR. Development of ITBS will avoid the technology dependency and provides the capacity to upgrade and improve the tsunami buoy system in house. However interface with iridium satellite telemetry could not be undertaken due to restriction from Department of Telecommunication.

The new buoy hull has been designed to increase the durability and field tests were conducted in the open sea successfully, along with model studies at IIT Madras, to compare the stability with actual buoy. The prototype Indian Tsunami Buoy and Bottom pressure Recorder (BPR) system (ITB01) – 'Sagar Bhoomi' was tested and deployed successfully in Bay of Bengal at depth of 3320m on 11th Oct 2015. The prototype system worked satisfactorily till retrieval in February 2016.



*Deployment of surface buoy system*



*Deployment of Sea bed Unit-BPR*

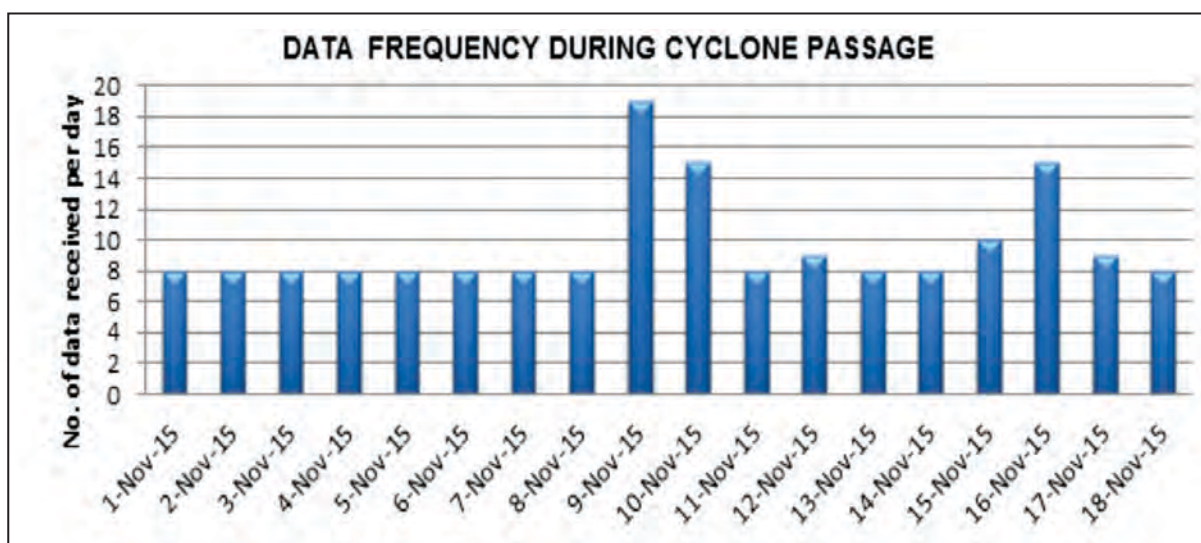


## Deployment of Indian Arctic Mooring–IndARC

The first polar underwater Indian moored observatory, 'IndARC-I', deployed in Arctic waters at 78°57' N / 12°01' E, at a water depth of 192 m was successfully retrieved on 15th July 2015 after successfully collecting continuous data for 357 days. The second polar underwater Indian moored observatory, IndARC II, incorporated additional sensors to measure Photosynthetic Active Radiation (PAR), nitrogen-based nutrient concentrations and ambient noise accounting to a total of 45 parameters was deployed on 19 July 2015. The design, development and installation of this underwater moored observatory were successfully executed by NIOT in collaboration with National Centre for Antarctic and Ocean Research, Goa. This in-house design effort to withstand harsh polar weather is a milestone achievement for the MoES and India. The objective of this program is to study the interaction of polar waters with the shelf water and in the deep sea during an entire seasonal cycle of the water transport into the interior part of the fjord. One of the major constraints in such a study is difficulty in reaching the location during the harsh Arctic winter and obtaining near-surface data. The IndARC observatory is an attempt to overcome this lacuna and collected continuous data from depths very close to the water surface as well as at different discrete depths. The data acquired would be of vital importance to the Indian climate researchers as well as to the international fraternity.

## Rapid Mode Data Collection during Cyclone

The rapid mode data collection during the passage of low pressure systems based on the specified threshold values of air pressure and wind speed is implemented in the data acquisition systems of data buoys. This system will switch over to rapid mode data collection if the thresholds are met.

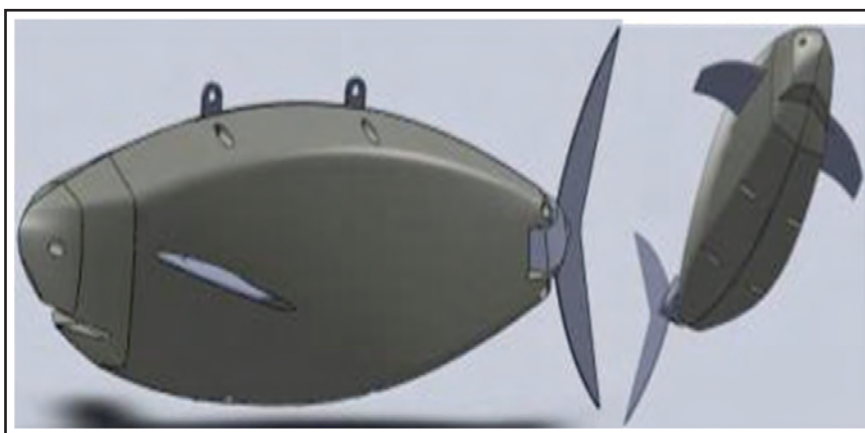


*Histogram showing total number of data received per day.*

After successful testing off Chennai during November 2015, Rapid Mode Data Collection was implemented in four coastal buoy systems (Chennai, Agatti, Goa and Andaman). Testing of similar algorithm for deep ocean buoy CPU is in progress and will be implemented in the upcoming deployments for deep sea buoys. The refinement of rapid mode transmission utilising the day-to-day difference in air pressure is under progress.

### **Design and Development of Autonomous Ocean Observation - Robotic Fish (AquaBot)**

As part of the developmental projects undertaken by OOS, second phase development of the laboratory scale AquaBot prototype with individually controlled pectoral fins for the pitch control and caudal fin for propulsion was manufactured and tested in marine environment. Modelling studies for an advanced version with more compliant hull and better hydrodynamic shape along with better manoeuvring capabilities is completed and prototype will be manufactured soon. The new compliant system would house a versatile pitching mechanism, variable buoyancy system and a moving mass mechanism to have redundancy in operation.



*Solid model of the prototype test vehicle ii - aquabot*

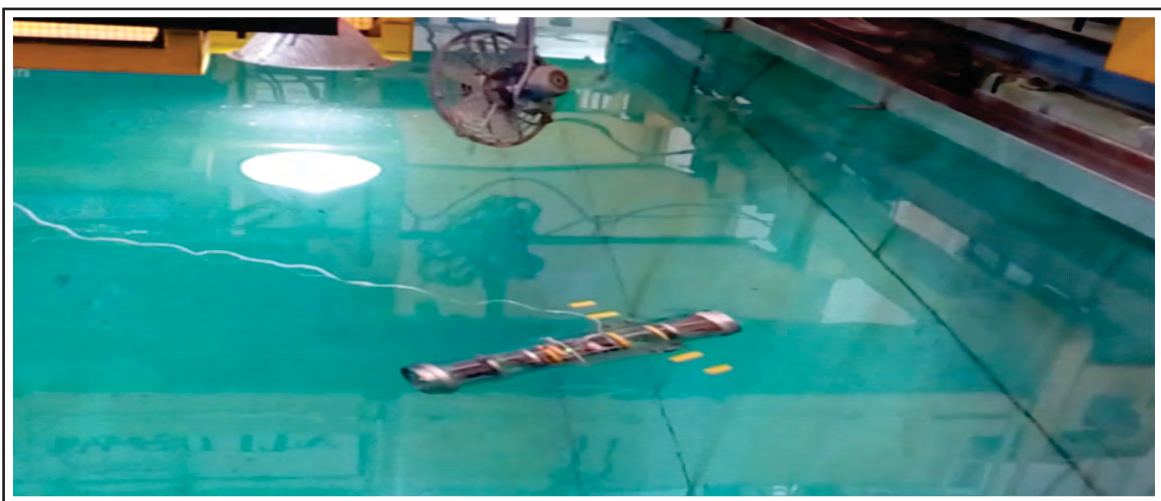
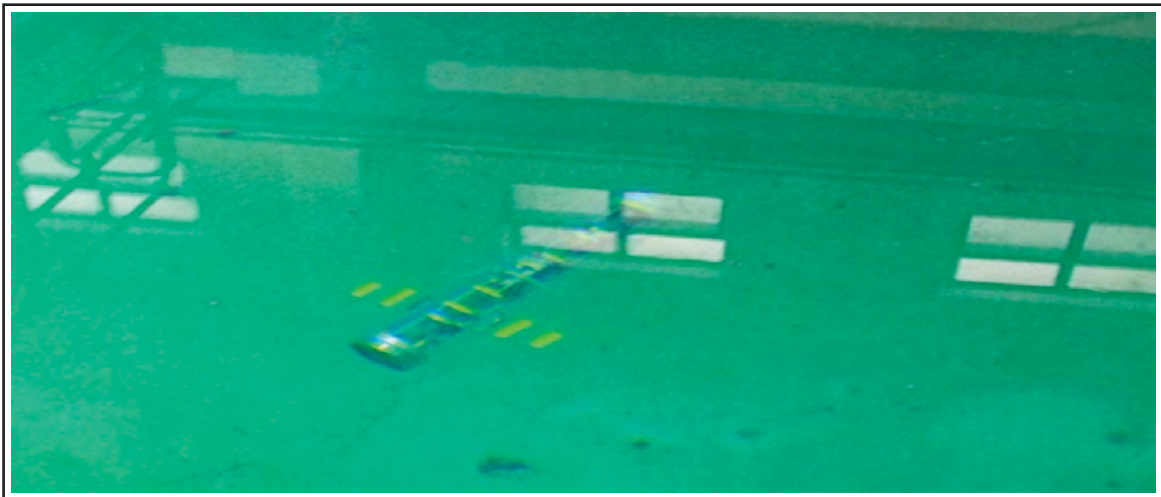
### **INSAT Buoy position tracker**

In continuation to the INSAT implementation in the coastal buoy systems for data transmission, a work is initiated to develop a buoy position tracker in case of failure in communication due to signal strength, damage to cable or antenna etc, This INSAT buoy position tracker will uplink the buoy position details in L band and the transmitted information is received and decoded. This has a salient feature of transmitting data once in a day during normal conditions and transmits in shorter intervals (1hr/3hr/6hr) in case of buoy drifting away from watch circle. INSAT Buoy position tracker was installed in TB12 buoy location on 14<sup>th</sup> November 2015 and working satisfactorily. This unit has been designed to work for a period of one year.



### **Design and Development of Laboratory Scale Underwater Glider**

Indigenously developed underwater Glider was tested successfully in the Acoustic Test Facility, using the dual buoyancy propulsion. The objective of this development is to control the buoyancy of the Glider system using dual buoyancy reservoirs. The present system consists of linear actuator mechanism for controlling the buoyancy. The proposed prototype has two reservoirs, located at the fore and aft part for buoyancy propulsion as well to attain glide angle. The glider operation was mainly constituted for pitching motion and could propel as pre-programmed using the microcontroller by the actuation of motor direction clockwise or anti-clockwise for the required type of operation, i.e pumping in or pumping out of water.



*Glider testing using the dual buoyancy systems*



## **VESSEL MANAGEMENT CELL**



***Sagar Nidhi in the Central Indian Ocean***





## **VESSEL MANAGEMENT CELL**

The main objective of Vessel Management Cell (VMC) is Operation, Maintenance and Management of MoES vessels. VMC is providing research vessels to various users under MoES & research institutes for successful implementation of Ocean related programmes as recommended by JSTAC (Joint Scientific and Technical Advisory Committee). VMC team is actively involved in technical management of vessels through periodic inspections, Organizing scientific facilities onboard, Planning and execution of scientific program as per JSTAC guidelines, Intervallic dry docking activities and also ensuring that all vessels fulfil Class requirements.

VMC team has implemented a number of innovative engineering solutions on research ships of NIOT, which has helped huge cost savings on maintenance and increased operational time. Other major activities of VMC includes, procurement of onboard scientific equipments and spares, preparation for all cruises, coordination with the team till end of cruise through offshore and onshore support for both scientific and ship team and procurement of new research vessels.

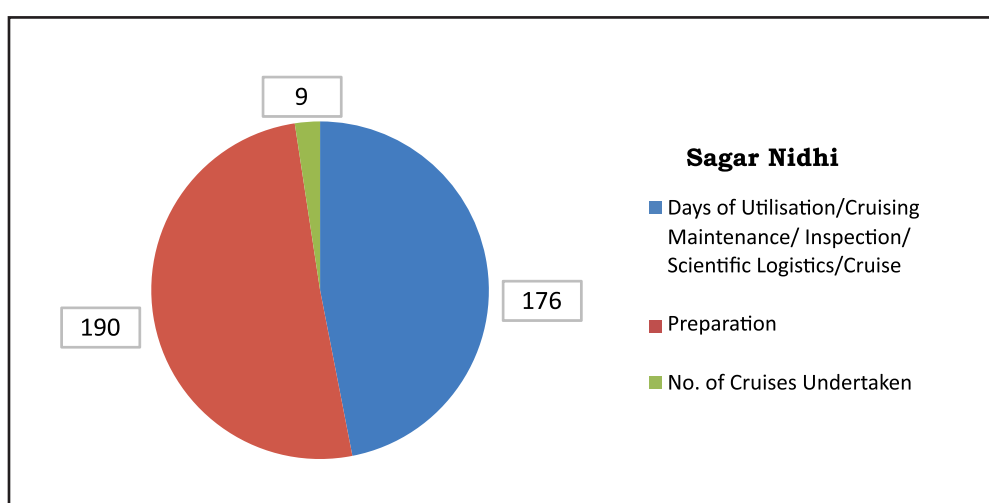
The coastal research vessel 'Sagar Purvi' is used for the implementation of the Coastal Ocean Monitoring and Prediction System (COMAPS) and Integrated Coastal and Marine Area Management (ICMAM) programmes of the Ministry of Earth Sciences and to provide services to the other agencies like Universities and Research Institutes for surveys and data collection.

The Buoy Tender Vessel 'Sagar Manjusha' is involved in the National Data Buoy programmes and other projects of the NIOT and other institutes. The Technology Demonstration Vessel 'Sagar Nidhi' is catering to the ongoing and the new programmes of the MoES such as the Autonomous Coring System (ACS), Deep Sea Mining, Remotely operable Submersible (ROSUB), Remotely Operable Vehicle (ROV), Autonomous Underwater Vehicle (AUV), International Indian Ocean Expedition (IIOE), Southern Ocean Expedition (SOE) supporting the Underwater Observations Systems and Instruments and to act as support platform for the various research and technology development activities planned by the Ministry.

## Vessel Utilization Report during 1<sup>st</sup> April 2015 to 31<sup>st</sup> March 2016

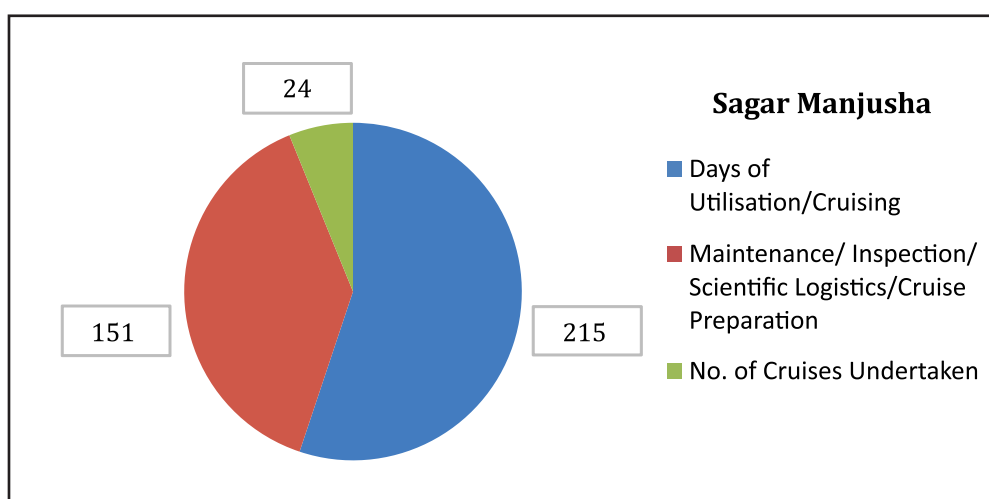
### Sagar Nidhi

Days at Sea / Utilization	Maintenance/ Inspection/Scientific logistics/Cruise preparation	No. of Cruises Undertaken
176	190 (Dry dock and Afloat repairs, Cruise Preparation for DST/MoHA clearance for DST team and Others, Annual Survey, DP Maintenance, Azimuth Thruster Repairs)	9



### Sagar Manjusha

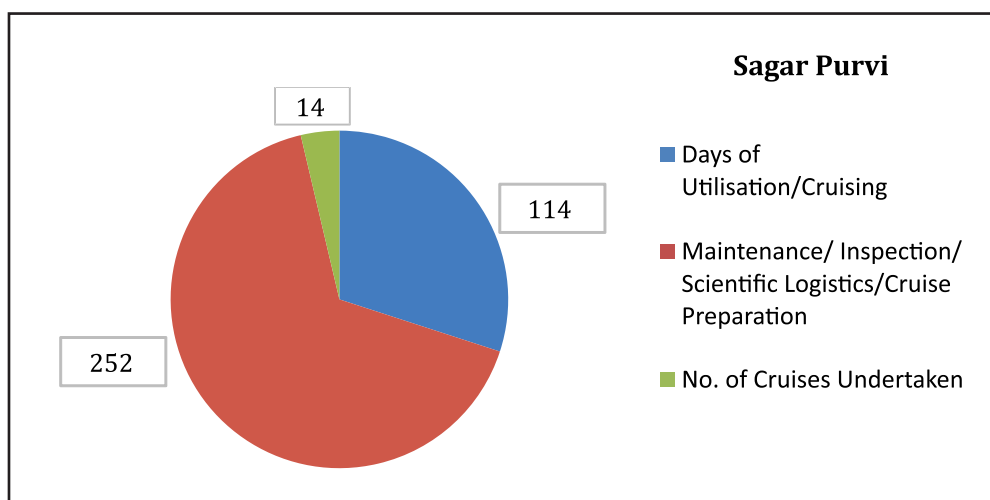
Days at Sea / Utilization	Maintenance/ Inspection/Scientific logistics/Cruise preparation	No. of Cruises Undertaken
215	151 (Insurance Valuation Survey, ISM Audit, Annual Survey, Adverse Weather, IFR Preparation)	24





## Sagar Purvi

Days at Sea / Utilization	Maintenance/ Inspection/Scientific logistics/Cruise preparation	No. of Cruises Undertaken
114	252 (Statutory Survey, Port Stay Due to Bad Weather/Cyclonic Warning, Statutory Survey, Plate Repairs, Waiting for Pamban Bridge Opening)	9



- Sagar Manjusha participated in International Fleet Review (IFR-16) organised by Eastern Naval Command, Visakhapatnam from 31<sup>st</sup> January, 2016 to 7<sup>th</sup> February, 2016. Honourable President of India Shri.Pranab Mukherjee participated in the Event 'President's Fleet Review' on 6<sup>th</sup> February, 2016. Navy and visitors appreciated the overall maintenance of Sagar Manjusha.



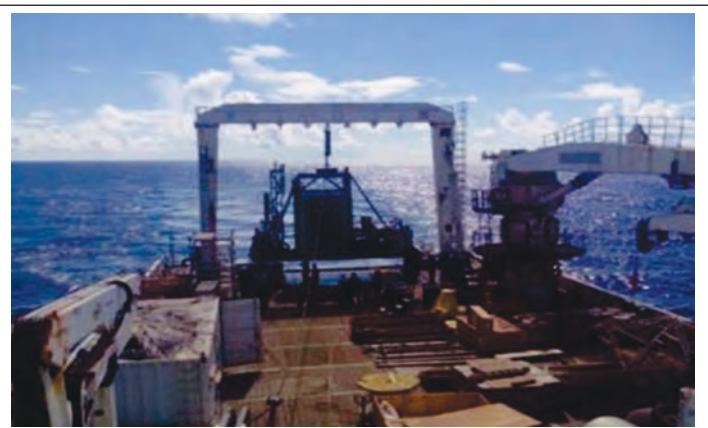
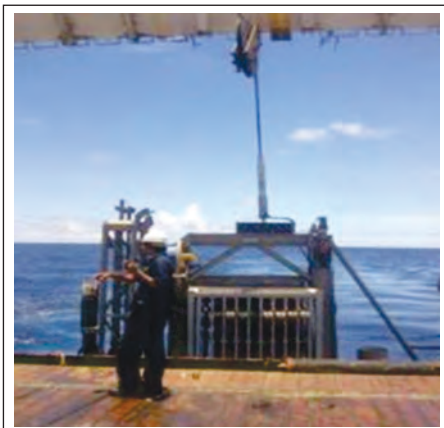
#### Scientific Activities of Sagar Nidhi:

- Successful completion of the first expedition of IIOE-2 (International Indian Ocean Expedition) from Goa to Mauritius as part of the concluding session of the International Symposium on "Dynamics of the Indian Ocean: Perspective and Retrospective".
- VMC team's effort and proficiency in handling operation & maintenance of scientific equipments without the AMC contractor onboard during the expedition was well appreciated by Scientists team. This led to huge savings towards cost of maintaining scientific equipments.
- Successful completion of Ocean Mixing and Monsoon cruise as part of National Monsoon Mission onboard Sagar Nidhi. VMC team provided an engineering solution for the installation of new Acoustic Doppler Current Profiler (ADCP) and supported scientific team to take record number of UCTD samples (4500 approximately).



*CTD operation, Bongo Net Operation  
Onboard and sample analysis*

- Successful trials of Wired Autonomous Coring System at Bay of Bengal:



*WACS trials at Bay of Bengal*



- Successful deployment and retrieval of Tsunami and OMNI Buoys
- Successful completion of Dry-dock & Afloat Repairs of Sagar Nidhi at Colombo Dockyard Public Limited Company, Srilanka



*Inspection of propeller, bearing*



*Dismantling of Bow thruster Motors*

#### **Sagar Purvi:**

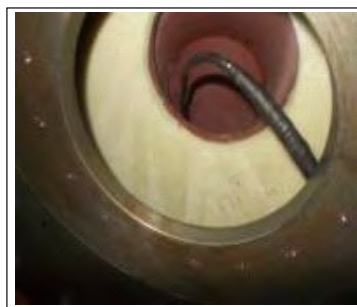
- Successful completion of Water, Grab and Corer sample and CTD data collection: NIO Goa.
- **Effective Supervision of Dry-dock and Afloat Repairs of Sagar Nidhi by VMC Team which saved cost and Shiptime**
  - VMC team provided engineering solution to fit new ADCP on the ship's hull without major modification which saved cost and Shiptime. Original Equipment Manufacturing engineer/scientists were also satisfied with the performance and data quality.



*Existing 38 kHz well*



*Adopter plate for 300 kHz*



*Acoustic Observer*

- VMC team provided engineering solution to introduce sleeves in bearing housing area of generators, which saved time and cost towards the procurement new end covers. The system is working satisfactorily.
- VMC team suggested a simple solution for dismantling of engine room blower assembly in-situ and saved valuable ship time and cost towards docking and manning charges. The system is working satisfactorily.

### Ship-time Gained due to technical intervention of VMC team

Sl. No	Activities	Ship-time Gained
1	Design, Fabrication and successful installation of ADCP fixtures without affect ing vessel undocking schedule.	<b>12 days</b>
2	Introducing sleeve in the drive and driven end housing of alternators	<b>3 months</b>
3	Established a methodology and successfully completed the overhauling of engine room blowers	<b>7 days</b>

#### ○ Status of Sagar Paschimi:

- M/s New India Assurance settled the H&M CTL insurance claim of Rs 1.5 crores.
- Protection and indemnity insurance club identified the salvors and contract was awarded.



*Sagar Paschimi wreck removal process*



### **Geoscientific Studies of the Exclusive Economic Zone of India [Shallow Water]**

- A survey coverage of approximately 3320 sq.km achieved using Multibeam echo sounder onboard Sagar Manjusha from April 2015 to March 2016 (Off Pulicat to Ramayapattnam & Off Krishnapatanam).
- Sound velocity data were collected from the same surveyed area for data processing.
- Data processing for SAMA06 cruise (1000 sq.Km) & SAMA19 cruise (150 Sq Km) was completed.
- Chart Preparation for SAMA06 bathymetry data is in progress.
- Total area covered so far is 12,654 Sq.Km.
- CTD data locations were plotted in ArcGIS.
- A team has been groomed under this project and entire work (sailing, data collection and data processing) is being done by VMC-NIOT team using NIOT Ships.

### **Constraints on Shallow Water Bathymetry Surveys:**

- Since frequent fishing activities in shallow waters and no auto pilot in CRVs, line survey at night time is practically difficult.
- Frequent net entanglement causes damage to the MBES system and side pole. Also time consuming for clearing the entanglements.
- Since ships being used for other scientific activities, side pole and equipment needs to be removed frequently, which is time consuming activity.
- Technical issues like Interfacing problems, system hanging etc.,
- Non availability of vessels for EEZ project is a major issue.

## CARBON DIOXIDE

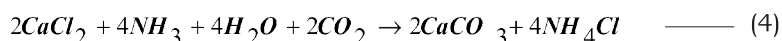
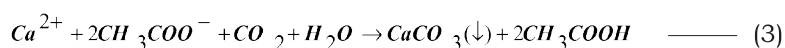
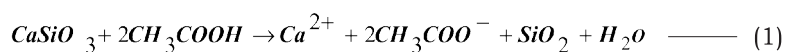
### OCEAN SEQUESTRATION TECHNIQUES

The objectives of Carbon di oxide ocean sequestration techniques group is to conduct experimental studies on CO<sub>2</sub> sequestration using industrial waste such as steel slag and feasibility studies on usage of the converted carbonated slag for the preparation of artificial blocks.

The role of increasing amount of greenhouse gases emission to the atmosphere is being studied to ascertain the adverse effects on the global climate. Considering the current level of the mean monthly concentrations of carbon dioxide (CO<sub>2</sub>) in the atmosphere reportedly reaching 400 ppmv, it is highly imperative to take note of the Intergovernmental Panel on Climate Change observation to take steps to identify the possible means of mitigation of the green house gases to control global warming, especially for carbon dioxide emissions with reference to the point sources such as power plants, iron and cement industries, etc. Since the iron and steel industry is reported to account for 3-5% of global carbon dioxide emissions, capture of the carbon dioxide emitted as flue gas from the industries and fixing in the industrial wastes such as slags containing oxides of calcium and magnesium is being considered in mineral carbonation. For conducting the carbonation experiments by utilizing the steel slag material a laboratory facility is established at NIOT. The work is being processed through the new initiatives on the Climate Change Studies program of the Ministry.

#### Lab Studies & Results Analysis

Indirect carbonation (using catalysts) is studied using acetic acid and ammonium chloride. The indirect method involves two step procedure namely extraction of calcium ions from the calcium silicate as shown in equation (1, 2) and after filtering the silica out of the solution, pumping carbon dioxide into the solution at 25 bar pressure for carbonation as indicated in equation (3,4).



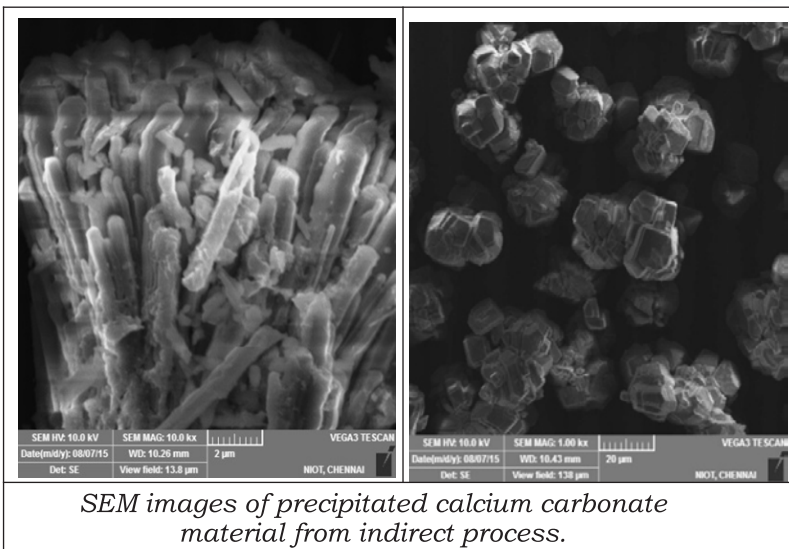
All the experiments of calcium extraction from steel slag with different solvents (2M concentration) were conducted at 50°C temperature and 500rpm stirring. The carbonation experiments were conducted at 80°C temperature, 500rpm stirring speed and 25bar CO<sub>2</sub> pressure.

By the addition of catalysts such as acetic acid and ammonium chloride the carbonation efficiency increases to 85% for acetic acid and 97% for ammonium chloride using carbon dioxide as the input.



## Scanning Electron Microscope Analysis

The structural and morphological analysis were conducted using the Scanning Electron Microscope (SEM) on precipitated calcium carbonate material attained from indirect method. The figure resembles the aragonite and calcite structures. The acicular and rhombohedral shapes of calcium carbonate material were obtained from the indirect



Carbonation method by acetic acid and ammonium chloride chemicals respectively.

## Artificial Blocks Preparation

Coastal regions experience depletion of beach sand that is identified to contribute to the erosion and loss of reef crests and increased wave energy at the shore. Studies show that the blocks made out of carbonated industrial wastes could be used for the artificial growth of corals in the sea and reclaim the lost coral assemblages. The test blocks are prepared using raw slag and carbonated slags material for Uniaxial Compressive Strength (UTM) analysis based on M-40 design. Based on the test results the bigger size blocks will be prepared and deployed in the open sea for ecological impact studies.

## Summary of the Studies

Laboratory scale experiments were conducted for carbonation process using steel slag and  $\text{CO}_2$  in high pressure and high temperature reactor set up. Indirect carbonation process gives higher carbonation efficiency when compared with the direct carbonation process (35-40%). It was found that carbonation efficiency increases to 85% by using acetic acid as catalyst and 97% for ammonium chloride as catalyst and using carbon dioxide as the input to slag material in the reactor. The energy involved in the indirect carbonation process is more when compared with the direct carbonation process. The morphological study using scanning electron microscope shows that formation of more carbonates in the indirect process acicular aragonites and rhomboidal calcites. The artificial test blocks were prepared and studies for compressive strength to utilize as artificial reef blocks. Studies indicate that the carbonation from industrial wastes can be optimized for energy efficiency and in turn can be utilized as artificial reef blocks to store carbon dioxide for long-term.

## COMPUTER MAINTENANCE CELL

Computer Maintenance Cell (CMC) of the National Institute of Ocean Technology, Chennai was set up in the year 1997 with the objective of providing computational and infrastructure facilities for the research community of the Institute. CMC administers, manages and caters to the needs of different projects, departments within the institute apart from in-house software development and maintenance.

CMC services the campus-wide Local Area Network (LAN) which caters close to 450 users. LAN has been designed with single mode fibre Optical Fibre Cable (OFC) backbone offering aggregate bandwidth of 1 Gbps.

NIOT has dedicated leased lines in the capacities of 1 Gbps from NIC and 25 Mbps from Vodafone respectively to ensure uninterrupted service to the user community. NKN established through NIC has 2 redundant connections as a failsafe arrangement.

The CMC core infrastructure facilities include several high-end servers with wide variety of operating systems like Windows, Unix, Linux, Redhat for intranet portal, web & mail services, FTP Storage and Application servers running key applications 24 x 7. Storage facilities include EMC 20 TB and HP 4 TB to support large volume of data.

Blade servers have been introduced to CMC's server room space. A blade enclosure (Chassis), can hold multiple blade servers (8 full blades or 16 half blades), provides services such as power, cooling, networking, various interconnects and management. Together, blades and the blade enclosure form a Blade System.

CMC maintains state of art Lotus Notes mailing system and online software for Stores & Purchase and Finance & Accounts built in house with which indenting, approvals, payroll and accounting applications are made online.



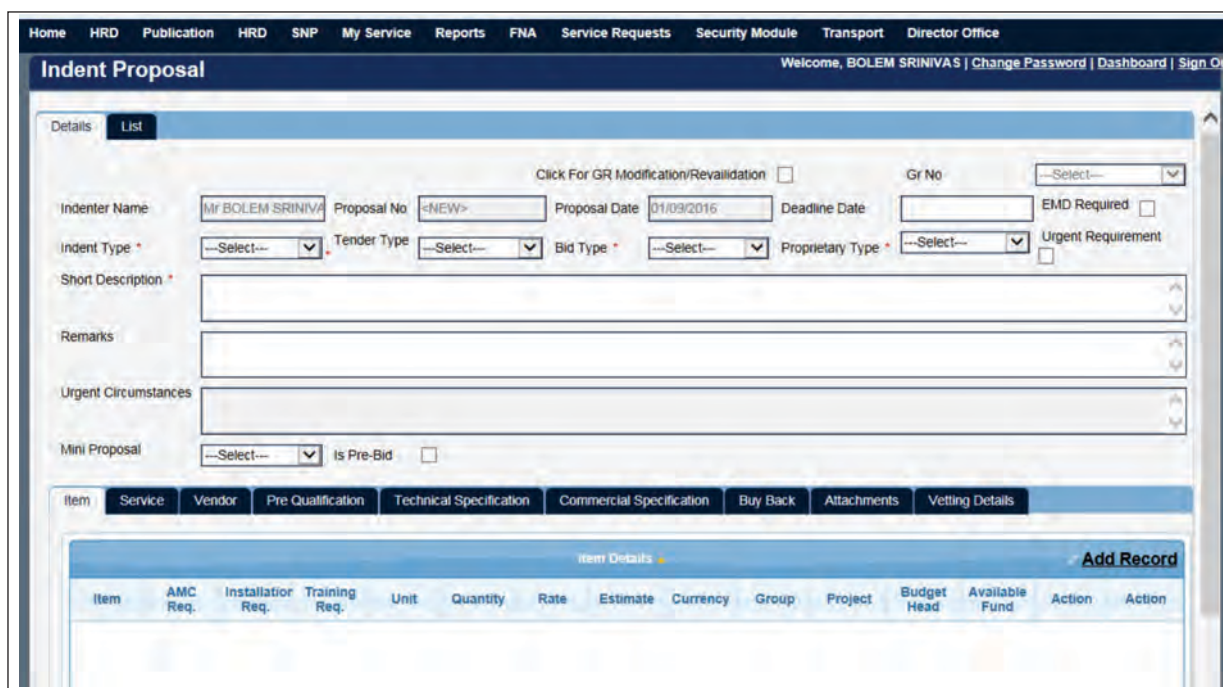
*Blade Servers*

CMC also maintains the video conference and 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.



## Integrated Office Automation System (IOAS)

Integrated Office Automation System (IOAS) is being implemented in NIOT moving towards paperless office as per Government of India guidelines. As a part of IOAS, all the interoffice communications through File tracking and management, Stores and Purchase module for procurement related workflow management from the stage of indent proposal to issue of Tender enquiry and Purchase orders, Finance module for payroll, reimbursements and vendor payments, Establishment and Personnel module for leave management, HR related processes, and other modules like Library, Publications, RTI, Director Office, Transport and Security modules for general administration are made available online and few modules are in the pipeline.



*Stores & Purchase online module - IOAS*

### Major achievements:

- Recovery from flood damage due to inundation through fast track service and replacement of affected systems by procurement through DGS&D mode.
- Implementation of IOAS modules in Stores and Purchase, HRD, Library, Publication, RTI, Director Office, Transport and Security.
- User acceptance test for other modules in IOAS are in the final stages.
- Streamlining of software procurement and annual maintenance support.

**Major software's that are being used by various departments and supported by CMC**

<b>Drafting and Modelling</b>	<b>Analysis</b>	<b>General Purpose Software's</b>	<b>Project Monitoring / Administrative</b>
AutoCAD* Solid Works Grapher Pro-E Mike C Map AEGIS ITI Simulation	Ansys* Orcaflex CFD - Fluent Surface Modelling Simulation X Mike 21 Plaxis STAAD Pro Arc-GIS* HTRI LMS Sysnoise	MathCAD* Lab View Matlab* Code Vision Conrad	Primavera Micro Soft Project Oracle SAP-2000

(The items with \* are procured and maintained by CMC)



## CAMPUS MAINTENANCE AND DEVELOPMENT

To cater the requirement of research activities of different groups at NIOT campus, following civil & electrical activities are undertaken.

Interior works for seating and laboratory arrangements including electrical, data and voice, fire fighting systems, surveillance system for Submersibles integration facility, VMC extension for office facility, Buoy test facility.

Supplying and installation of 6 passenger lift in VMC extension for office facility has been completed. Supply and installation of material handling lift with capacity of 1000kg and 200 kg at new storage yards are in progress. Supply and installation of 20 T EOT crane at Submersibles integration facility and 5 T EOT crane at OOS bay extension are in progress.



*20T EOT at New Integration Bay*



*5T EOT at OOS Extension*

### Damages due to floods in December 2015

The NIOT campus was completely inundated by recent floods. Many of equipment, on the ground floor, were affected by the recent floods in Dec 2015. Electrical and electronic sub-systems were the most affected. Systems have been revamped by systematic cleaning and drying of the components such as transformers, electrical contactors, processors etc. Some of the pictures of flood affected equipment are shown below.

Flood restoration works such as servicing of electrical HT panel, transformers, generators at utility building, interior works at MBT office ground floor, painting at various places, servicing of existing chairs and repairing of existing tables/storage units have been completed.



*Campus status after the December 2015 floods*

### **Reconstruction of compound wall and Common Facility**

The compound wall at eastern side of NIOT campus is reconstructed to a length of 220 m to ensure the safety of the campus, rehabilitation of interior work at ICMAM training hall, construction of electrical panel room, extension of Geo-Tech lab and providing paver block around the lab to enhance open storage,



*Newly constructed electrical panel room*



*Modification of MBT - Office*



*Serviced HT panel*



## LIBRARY

The library has been supporting the research and development programs of the institute and providing physical and intellectual access to information, catering to the present and the anticipated technical and research functions of the institute. The main objectives of the library are to acquire, maintain and develop a comprehensive collection of books, journals and documents useful for the research community of the institute. The collection of the library includes hindi books, standards and national hydrographic maps in the fields of ocean engineering, marine science and technology.

The total holdings of the library exceed 5300 volumes covering a wide range of books in Engineering, Science and Technology, and a collection of Hindi Literature / Material. The valuable collection has some of the rare reference materials and important journals to cater to the information needs of the scientific, technical and also administrative communities of NIOT.



*Reading section of the library*



*Section for display of latest periodicals*

The centrally air-conditioned library has a reading section and online browsing facility; and also a Periodicals section for Newspapers, Magazines and Journals. A total 26 international journals and 5 Hindi magazines are subscribed for hard copy editions and 117 journals are subscribed online through a consortium arrangement of MoES with Science Direct. Library also updates the digital repository under the Ministry website to facilitate dissemination of the information regarding the research papers published in the National and International journals.

An Inter Library Loan facility is established with organizations such as Central Library IIT-Madras, British Library and Anna University. An Integrated Library Management package is used in the library to manage activities such as document issue / return / renewal / reservation. Also, the users can know the latest additions of collection and the status of a document.



## IMPLEMENTATION OF OFFICIAL LANGUAGE

Implementation of Official Language policy has been set up in NIOT Chennai in accordance with instructions issued by Department of Official Language and the Hindi cell of NIOT has ensured maximum bilingual correspondences.

### Hindi training

- **Training through intensive training program** - 3 staff members have passed 'Prabodh' and 7 staff members have passed 'Praveen' course. They were given cash awards and personal pay for period of 1 year was also granted to eligible staff members.
- **Training through Correspondence Course** - 32 staff members were nominated for Hindi training through correspondence course in Prabodh, Praveen and Pragma.
- **Status of trained staff members** - Out of 167 existing staff members, 109 (65.27%) staff members are trained in Hindi as on 31-03-2016 as per roster maintained.

### Hindi Typewriting course

1 staff has been nominated for training in Hindi Typewriting in 1st session (February-July 2016) and 1 staff for training in 2<sup>nd</sup> session.

### Hindi Fortnight Celebrations

NIOT celebrates Hindi fortnight every year. During 2015-16, Hindi fortnight was celebrated with enthusiasm between 1<sup>st</sup> and 14<sup>th</sup> September 2015. Various competitions were conducted separately for Hindi speaking and Non-Hindi speaking employees. Staff members have participated in the competition in large numbers. The staff participated were awarded prizes in the prize distribution function held under the chairmanship of Dr. Purnima Jalihal, Scientist G, NIOT with Mr. Hariom Rastogi, Dy. Director (Incharge), Hindi Teaching Scheme (HTS) as the Chief Guest.

### Hindi workshops

A total of six hindi workshops were conducted during the year on various subjects to strengthen the knowledge of staff members and to motivate them to work in Hindi. A total of 156 staff members have actively participated.

### Hindi Awareness Program for Project / Outsourced staff

A Hindi awareness program was organized during March 2-3, 2016. A total of 55 staff members have participated therein.

### Quarterly reports for progressive use of Hindi

Quarterly reports (on line) on use of Hindi for the quarter ending 30-6-2015, 30-9-2015, 31-12-2015 and 31-3-2016 were prepared and sent to Regional Implementation Office, Cochin and MoES, New Delhi.

### **Official Language Implementation Committee meetings**

4 meetings of Official Language Implementation Committee (OLIC) meetings were conducted during the year on i) 09-7-2015 (for quarter ending 30-6-2015), ii) 02-11-2015 (for quarter ending 30-9-2015), iii) 29-01-2016 (for quarter ending 31-12-2015), iv) 17-4-2016 (for quarter ending 31-3-2016).

### **Participation in Annual Regional Official Language Conference**

Shri G.V. Reddy, Senior Administrative Officer, NIOT participated in the Annual Regional official Language Conference held on 19th February 2016 at Cochin.

### **Participation in Rashtriya Hindi Vaigyanik Sangosthi**

NIOT represented in the National Hindi Scientific Seminar on "ROLE OF OCEANS IN OUR LIFE" held during September 28-29, 2015 at INCOIS, Hyderabad and sponsored the event with an amount of Rs. 2.00 lakh.

### **Participation in TOLIC meetings**

NIOT represented its representatives in the Town Official Language Implementation Committee (TOLIC) meetings held on 06.05.2015 and 21.12.2015.

### **Contribution for TOLIC**

An annual contribution of Rs.1500/- was made to TOLIC for conduct of various activities. Further, an amount of Rs. 10,000/- was contributed to TOLIC on their request for conduct of Joint Official Language Conference. Informatively, NIOT received "Vishisht Yogadata Karyalaya" memento in the meeting / conference held on 21st December 2015.



## TRAININGS / MEETINGS

### Training programme on ocean data collection by M/s Seabird scientific, USA

As part of capacity building, M/s seabird scientific conducted a training programme on ocean data collection during 9<sup>th</sup> to 11<sup>th</sup> February 2016 at NIOT, Chennai. Sixty Participants from various institutes and organisations in India participated in this training programme.



### Training programme on nuances of small scale community farming

A 3 days training programme was organized for fisher folks of Venangupattu (Tamil Nadu) to explain the nuances of small scale community farming (cage designing, culture economics and cage fabrication) in collaboration with Central Institute of Brackish water Aquaculture, Chennai on 4<sup>th</sup> March, 2016 at NIOT, Chennai.



### Training programme on Operational Safety in Vessels

Ocean Observation Systems organized a safety training programme on "Operational Safety in Vessels" is conducted for the staff members on 15<sup>th</sup> October 2015 at NIOT.

## STAFF RECREATION CLUB / STAFF WELFARE ACTIVITIES

The Staff Recreation Club (SRC) formed under the chairmanship of Director aims to promote various talents of staff members through sports, cultural, literature and recreational activities. The SRC has conducted 16 sports events for the staff members (Men/Women) under 50 categories during July/August 2015 and distributed certificates and prizes for the winners. The total participation accounts to 550 under various competitions for men and that of women are 150.



*Badminton –Singles Final match*



*Carrom doubles match*



*Children events conducted on 15/08/2015*



*Prize distribution to the winners*



Coloring and Pencil sketching competitions were conducted for children as part of Independence Day celebrations. Prizes and certificates were distributed under various categories and painting kits were distributed to all participants.

These celebrations at NIOT are made memorable with many events organized by Staff Recreation Club for staff and family and distributed the prizes.

## CONFERENCES / WORKSHOPS

### Workshop on Best Practices in Submersible Designs

The Workshop on Best Practices in Submersible Designs on January 21, 2016 at NIOT was conducted on behalf of The Institute of Electrical & Electronics Engineers (IEEE) Oceanic Engineering Society (OES). 19 institutes and 46 students were participated. Various ocean Engineering technical lectures were delivered by NIOT scientific team during the workshop. Mr. Emerson Hasbrouck from Woods Hole Oceanographic Institution (WHOI), USA delivered a lecture on subsea O-rings, cables and connectors.

### International Women's Day Celebration

As a mark of International Women's Day Celebration, a 'Women Only Workshop (WOW) on Personal Finance' was organized by NIOT on 9<sup>th</sup> March 2016. It was conducted by Mrs. Renu Maheshwari, a SEBI registered investment adviser, and all women staff of NIOT attended the workshop.





## Republic Day Celebrations

The 67<sup>th</sup> Republic Day was celebrated at NIOT on 26<sup>th</sup> January 2016. Dr. SSC. Shenoi, Director, NIOT hoisted the national flag in front of the main building.





### Independence Day Celebration

The 69<sup>th</sup> Independence Day celebration was conducted at NIOT on 15<sup>th</sup> August 2015. Director, NIOT hoisted the national flag followed by various events for kids. Kids participated under painting, colouring and pencil sketching competitions and prizes were distributed. Prizes to various sports events conducted for the staffs during July-August 2015 are also distributed on the day.



## STUDENT AUTONOMOUS UNDERWATER VEHICLE (SAVE) COMPETITION

National Institute of Ocean Technology under the Ministry of Earth Sciences organizes a competition for students pursuing engineering degree to visualize and design an autonomous underwater vehicle. The main focus of this competition is to involve students on the new frontier areas of ocean technology and kindle their innovative thinking in this unexplored area of ocean environment and observation. NIOT supports the winning team with their technical expertise and also sponsor for the International competition being held annually in AUVSI foundation San Diego, USA.



SRM University, Chennai achieved the basic targets of competition and selected as Winner of the Competition of SAVe 2015 during fourth National level competition. NIOT sponsored the team to participate in the International AUVSI competition held at San Diego in 2015. SRM University team, consisting of 5 Student Members with one lead faculty reached semi-finals among 36 international teams.

Fifth National level competition for students on design an autonomous underwater vehicle was announced on 15<sup>th</sup> May 2015. 22 teams submitted the Preliminary Design Report and 20 teams were selected for next level. The Conceptual Design Report review was conducted at NIOT campus on 22<sup>nd</sup> January 2016. Twenty teams (86 students) from various Engineering Institutes presented their design concepts and 14 teams were qualified for the final national competition to show case their working AUV.



## ISO Certification

NIOT has obtained ISO 9001: 2008 certification for the administrative sections such as Planning and Management, Finance and Accounts, Stores and Purchase, Establishment and Personnel, Estate and Maintenance, Library, Director's Secretariat, Computer Maintenance, Security, Transport and Logistics and Human Resource Development. The recertification audit was successfully completed and certification has been obtained till September 2018.



## VISIT OF DIGNITARIES

### Visit of HMoES

- Dr. Harsh Vardhan, Hon'ble Union Minister for Ministry of Science and Technology & Ministry of Earth Sciences visited NIOT ANCOST, Port Blair on April 1, 2015 and visited the labs and addressed the staff appreciating the activities being carried out at ANCOST NIOT.



### Visit to MoS

- Shri.Y.S.Chowdary, Hon'ble Minister of State for Science and Technology and Earth Sciences, Govt. of India visited NIOT facilities on 16<sup>th</sup> October 2015 and appreciated the achievements.

### **New Sea Front Facility**

The corner stone laying function of the ocean research facility of NIOT Nellore was held on 25<sup>th</sup> April 2015 at Pamaji & Vagaru Villages, Vakadu Mandal, Nellore. The Honorable Union Minister for Science and Technology and Ministry of Earth Sciences Dr. Harsh Vardhan and Hon'ble Minister of State for Ministry of Science & Technology & Earth Sciences Shri. Y.S. Chowdary, laid the corner stone for the new campus. This function was presided by Shri N. Chandra Babu Naidu, Hon'ble Chief Minister of Andhra Pradesh and with the august presence of other Ministers.



### **Biodiesel fueled NIOT vehicle**

B-10 biodiesel fueled NIOT vehicle was successfully operated from Nellore to Chennai on 25<sup>th</sup> April 2015 after it was flagged off by the Secretary, MoES on behalf of the Union Minister Dr. Harsh Vardhan.



Handing over of B-10 biodiesel to Dr. Shailesh Nayak, Secretary, MoES



## Technology Day

Technology Day was celebrated on 11<sup>th</sup> May 2015 at NIOT. Dr.M.Y.S.Prasad, Director, Satish Dhawan Space Centre, SHAR, Sriharikota, ISRO, DOS, Government of India, was invited as the Chief Guest. Quiz competition for Scientists and identification of instruments competition for admin staff were organized and prizes were awarded to the winners.



## NIOT Foundation Day

The 22<sup>nd</sup> Foundation day of NIOT was celebrated on 6<sup>th</sup> November 2015. Dr.Shailesh Nayak, Former Secretary MoES, Government of India was invited as the Chief Guest and he gave the Foundation day lecture. Dr.S.S.C.Shenoi, Director, NIOT gave the welcome address. An Open house for students was held and prizes were awarded to the winners.



### **Electrochemistry & Corrosion Camp - 2015**

National Institute of Ocean Technology (NIOT), Ministry of Earth Sciences (MoES), Government of India, Chennai supported the Electrochemistry & Corrosion Camp-2015, which was Jointly organized by SAEST, Kalpakkam Chapter & NACE International Gateway India Section (South Zone) during 21-22 August 2015. As a part of awareness on corrosion, NIOT arranged the industrial visit for 97 students and 23 teachers/organizers, from 15 different schools, including 3 Kendriya Vidyalaya Schools, Sri Sankara Senior Secondary School Adyar, Chennai on 21<sup>st</sup> August 2015.

Dr. R Venkatesan, Scientist-G and Head - Ocean Observation Systems coordinated this visit for students and arranged video presentation, lecture and visit to the NIOT facilities. Students and Teachers showed interest and interacted with scientists. They were appreciative to learn about marine corrosion and biofouling issues being faced in ocean technology projects and related combat measures being undertaken and also expressed their satisfaction.

### **Swachh Bharat Activities**

As part of Swachh Bharat activities, in accordance with the direction to work on cleaning activities for two weeks during February to March 2016, NIOT made a systematic attempt to clean old scrap lying on the campus. All scrap items including wood, metal pieces, plastic, chemicals and other non-asset items were segregated. The entire NIOT staff was divided into several groups. Each group was assigned a specific zone of the campus for the cleaning activity. The scrap was segregated and placed in the identified locations. Following tender procedures as per the GFR guidelines, the scrap was disposed off.

Swachh Bharath programme was also organized at ANCOST Campus, Port Blair on 17<sup>th</sup> October 2015.



*Swachh Bharat activities at NIOT, Chennai and  
NIOT ANCOST Campus, Port Blair*





## AWARDS

### MoES Award

The following staff of NIOT have received the MoES awards for the year 2014-15 during the Foundation Day of Ministry of Earth Sciences (MoES), held on July 27, 2015 at New Delhi

- The “Certificate of Merit” young Scientists / Engineers Award in the field of Ocean Sciences and Atmospheric Sciences has been awarded to:

Dr.N.V.Vinith Kumar, Scientist-E

- The “Best Employee Award” has been received by the following staff:

Smt D.Latha, Sci.Asst.Gr.B

Shri G.Vengatesan, Sci.Asst.Gr.B

Shri S.Guru Prasad Rao, Jr.Executive

Smt.C.Easwari, Jr.Executive

Shri H.H.Junaid Ahmed, Technician Gr.B

Shri P.G.Pradeep

### NIOT Award

The following staffs of NIOT have received the NIOT Awards 2015 during the 21<sup>st</sup> Foundation Day of NIOT, held on 6<sup>th</sup> November 2015.

Name	Designation
Shri M.Murugan	Scientific Assistant Grade B
Shri T.Gnanadhas	Project Scientific Assistant
Shri T.Babu	Project Scientific Assistant
Ms.Lakshmi Vijayakumar	Project Scientific Assistant
Shri T.Karthikeyan	Project Scientific Assistant
Shri G.Suresh	Project Scientific Assistant
Shri S.Murali	Project Scientific Assistant
Shri A.Naresh	Project Scientific Assistant
Shri B.Parmeswar	Technician Grade A
Shri T.Nambirasan	Project Technician
Smt.I.Srilakshmi	Project Senior Executive
Smt.C.Anitha	Project Junior Assistant

**Best Journal Publication award** was given to Shri S.Najeem, Project Scientist-I of Ocean Acoustics group.

### National Maritime Search and Rescue Award

**Sagar Manjusha** received the prestigious '**National Maritime Search and Rescue Award**' on 17<sup>th</sup> July, 2015 for the rescue/towing plan extremely well prepared by VMC team and executed by Ship Crew/VMC-Scientist onboard towards nature's fury while saving life of 12 fishermen and their fishing vessel Kesavan at mid sea.

### Women Achievers Award

Dr.G.Latha, Scientist F and Head of Ocean Acoustics programme received the Women Achievers Award from VELS University in the category "Women in Science" on the occasion of International Women's Day along with other Distinguished Women Achievers in different fields.

### Best paper award

Lydia Kiruba.R, M.Arul Muthiah, K.Gokulakrishnan, A.Sivagami, R.Venkatesan, "A VLSI based novel technique for data collection from Polar subsurface instrumented mooring", has been presented and selected as a best paper in International conference ICACCT'15, held at Anna University, BIT campus, Trichirapalli, during 11-12, April 2015.

### Patent granted

Authors	Title of the invention	Patent granted reference No./date	Country
Kirubakaran, R., Thirupathi, K.,Atmanand, M.A., Dharani,G., Vinith Kumar, N.V., Mary Leema, T and Magesh Peter. D	A Microalgal harvesting system	Appln. No 20 2015 104 046.6 Patent granted reference No. IPC: C12M 1/42 (2006.01), Dated 04-11-2015	Germany

### Patents Filed

Authors	Title of the invention	Patent filed Application No./Date	Country
Prasad, Nagasamy, Purnima Jalihal, Leo, Biren	A cross flow hydrokinetic device coupled with a synchronous generator with constant magnetic poles to extract electric power from low speed water currents	4800/CHE/ 2015 / 10.10.2015	India
Kirubakaran, R., Thirupathi. K., Atmanand, M.A., Dharani,G., Vinith Kumar, N.V., Mary Leema, T., and Magesh Peter. D	A Microalgal harvesting system	1991/CHE/ 2015 dated 17.04.2015 & UK: 1513969.4 dated 07/08/2015	India & United Kingdom



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### International Journals

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2. Venkatesan R, Ramasundaram S, Sundar R, Vedachalam N, Lavanya R, Atmanand M.A, “*Reliability Assessment of State-of-the-Art Real-Time Data Reception and Analysis System for the Indian Seas*”, **Marine Technology Society Journal**, Vol. 49 (3), pp. 127-134, May 2015.
3. Vedachalam N, Ramesh S, Jyothi V.B.N, Thulasi Prasad N, Ramesh R, Sathianarayanan D, Ramadass G.A, Atmanand M.A, “*Evaluation of the depressurization based technique for methane hydrates reservoir dissociation in a marine setting, in the Krishna Godavari Basin, east coast of India*” **Journal of Natural Gas Science and Engineering** Vol. 25, pp. 226–235, July 2015.
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8. Mullai Vendhan K, Ramana Murthy M.V, Sundar V, “*On estimation of wave forces on seawater intake caisson in high energy environment using field investigations*”, **Procedia Engineering**, Vol. 116, pp. 300–309, 2015.
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10. Balaji D, Raju Abraham, Phani Kumar S.V.S, M.V. Ramana Murthy, “*Experimental and comparative study of a sea water cooled surface condenser of LTTD plant with HTRI and Kern method*”, **Desalination and Water Treatment**, ISSN: 1944-3994, 2015.
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24. Jha D.K, Devi M.P, Vidyalakshmi R, Brindha B, Vinithkumar N.V, Kirubakaran R, “*Water quality assessment using water quality index and geographical information system methods in the coastal waters of Andaman Sea, India*”, **Marine Pollution Bulletin**, Vol. 100, pp. 555–561, 2015.
25. Anburajan L, Meena B, Vijaya Raghavan R, Divya Sridhar, M.P, Toms C. Joseph, Vinithkumar N.V, Dharani G, Dheenani P.S, Kirubakaran R, “*Heterologous expression, purification and phylogenetic analysis of oil degrading biosurfactant biosynthesis genes from the marine sponge-associated Bacillus licheniformis NIOT-06*”, **Bioprocess and Biosystems Engineering**, Vol. 38, pp. 1009–1018, 2015.
26. Deepa S, Sathish T, Vinithkumar N.V, Limna Mol V.P, Kirubakaran R, “*Distribution and diversity of macro-foulers in the coastal areas of Port Blair, Andaman and Nicobar Islands*”, **International Journal of Environmental Research**, Vol. 9, pp. 1315-1324, 2015.
27. Najeem S, Latha G, Sanjana M.C, Thirunavukkarasu A, “*Reflection loss estimation using shallow water ambient noise in the Arabian Sea off the west coast of India*”, **Ocean Engineering**, Vol. 109, pp. 603-610, 2015.
28. Kannan R, Sanjana M.C, Latha G, “*Passive Acoustic Recognition of Fishing Vessel Activity in the Shallow Waters of the Arabian Sea: A Statistical Approach*” **Fluctuation and Noise Letters**, Vol. 14 (4), pp.1550035-46, 2015.
29. Meena B, Anburajan L, Sathish T, VijayaRaghavan R, Vinithkumar N.V, Dharani G, Kirubakaran R, “*L-Asparaginase from Streptomyces griseus NIOT-VKMA29: optimization of process variables using factorial designs and molecular characterization of L-asparaginase gene*”, **Nature Scientific Reports 5**, Article no.12404, 2015.



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31. Balaji.D, Prakash LSS, “*CFD analysis of a pressure drop in a staggered tube bundle for a turbulent cross flow*”, **International advanced research journal in science, engineering and technology**, Vol.3 (2), February 2016.
32. Doss Prakash V, Umapathy A, Vedachalam N, Vadivelan A, Ramesh R, Ramadass G.A, Atmanand M.A, “*Analysis of subsea inductive power transfer performances using planar coils*”, **Marine Technology Society Journal**, Vol. 50 (1), pp. 17-26, February 2016.
33. Vedachalam N, Ramesh S, Srinivasalu S, Rajendran G, Ramadass G.A, Atmanand M.A, “*Assessment of methane gas production from Indian gas hydrate petroleum systems*”, **Applied Energy**, Vol. 168, pp. 649-660, February 2016.
34. Sanjana M.C, Latha G, Potty G.R, “*Geoacoustic inversion in shallow tropical waters for a silty and sandy seabed*”, **Journal of the Acoustical Society of America**, Vol.139 (2), pp. 38-44, February 2016.
35. Vedachalam N, Ramesh R, Jyothi V.B.N, Ramadass G.A, Atmanand M.A, “*An approach to operational risk modeling and estimation of safety levels for deep water work class ROV: A case study with reference to ROSUB 6000*”, **Journal of Ocean Engineering and Sciences** Vol. 1 (2), pp. 109–118, April 2016.
36. Balaji D, Raju Abraham, Ramana Murthy M.V, “*Experimental study on the vacuum load of low temperature thermal desalination plant*”, **Desalination and water treatment**, ISSN: 1944-3994, 2016.
37. Balaji D, Jayaraj K, Phanikumar S.V.S, Ramana Murthy M.V, “*Water quality improvement studies in LTDD plant*” **Desalination and water treatment**, ISSN: 1944-3994, 2016.

38. Balaji.D, “*Experimental study on the effect of feed water nozzles on non-equilibrium temperature difference and flash evaporation in a single –stage evaporator and an investigation of effect of process parameters on the liquid flashing in a LTTD desalination process*” **Desalination and water treatment**, ISSN: 1944-3994, 2016.
39. Rajasekhar D, Ananthakrishna, Deepaksankar P.S, Narendrakumar D, Ramasundaram K, “*Development of Methodology for Managing Effects of Marine Corrosion using FE Approach*”, **International Journal of Engineering Science and Innovative Technology**, Vol. 5 (1), pp. 113-123, 2016.
40. Lix J.K, Venkatesan R, George Grinson, Rao R.R, Jineesh V.K, Muthiah M. Arul, Vengatesan G, Ramasundaram S, Sundar R, Atmanand M.A, “*Differential bleaching of corals based on El Niño type and intensity in the Andaman Sea, southeast Bay of Bengal*”, **Environmental Monitoring and Assessment**, 188:175, 2016.
41. Venkatesan R, Vengatesan G, Vedachalam N, Arul Muthiah M, Lavanya R, Atmanand M.A, “*Reliability assessment and integrity management of data buoy instruments used for monitoring the Indian seas*”, **Applied ocean research**, Vol. 54, pp.1-11, 2016.
42. Dheenana, P.S, Jha D.K, Das A.K, Vinithkumar N.V, Devi M.P, Kirubakaran R, “*Geographic information systems and multivariate analysis to evaluate fecal bacterial pollution in coastal waters of Andaman, India*”, **Environmental Pollution**, Vol. 214, pp. 45-53, 2016.
43. Najeem S, Noufal K.K, Latha G, “*Estimation of seabed properties using ambient noise from shallow waters of Indian continental shelf*,” **Marine Geodesy**, vol. 39 (1), pp 21-31, 2016.



### National Journals

1. Prince Prakash Jebakumar J, Nandhagopal G, Sundradarajan S, Karuppasamy M, Ragumaran S, “*Eminence of heavy metal accumulation in fishes and crustaceans from the Gulf of Khambhat, India*”, **Current Science**, Vol. 109 (3), pp. 409-412, 2015.
2. Roshinebegam K, Selvakumar S, Sundararajan S, “*Assessing of Water Quality Pollution Indices for Heavy Metal Contamination of Periyar River, Tamil Nadu and South India*”, **Chemical Science Review and Letters**, Vol. 4, pp. 153-163, 2015.
3. Madan M Mahanty, Latha G, Thirunavukkarasu A “*Analysis of humpback whale sounds in shallow waters of the Southeastern Arabian Sea: An indication of breeding habitat*”, **Journal of Biosciences**, Vol. 40 (2), pp. 407–417, June 2015.
4. Rajasekhar D, “*Rescue on the High Seas! ORV SAGAR MANJUSHA-THE SAVIOR!*” **Science Reporter**, Vol. 52 (11), pp. 34-37, November 2015.
5. Thulasiprasad N, Murthy K.N.V.V, Sridhar M, Sadhu S, Dharani G, Ramesh S, Phani Kumar S.V.S, Atmanand M.A, Venkata Rao M.B, Syamsundar A, “*Ocean Applications for Carbon Dioxide Sequestration*”, **In: Geologic Carbon Sequestration**, Vol. 12, pp. 231 – 245, 2016.
6. Mahanty M.M, Latha G, Edwards Durai P, “*Soundscapes in the shallow waters off Southwest coast of India during pre-monsoon season*”, **Journal of Acoustical Society of India**, Vol.43 (1), pp. 9-17, January 2016.
7. Dhilsha Rajapan, Sayanti Bardhan, Sreedev D.S, Shijo Zackaria, Mahimol Eldhose, Shibu Jacob, Atmanand M.A, “*Performance Comparison of Beamforming Algorithms for Buried Object Detection*”, **Journal of Acoustical Society of India**, Vol.43 (1), pp. 48-53, January 2016.
8. Kannan R, Latha G, Prashanthi Devi M, “*Short term shallow water ambient noise variability off Kakinada during northeast monsoon*”, **Journal of Acoustical Society of India**, Vol.43 (1), pp. 54-59, January 2016.

## PAPERS PRESENTED IN CONFERENCES

### International Conferences

1. Selvakumar S, RoshineBegam K, Sundararajan S, “*Assessment of water quality index and water suitability of the Periyar River for drinking purpose, Tamilnadu, India*”, **Recent Trends in Modern Biology & 46th Aqua-Terr Annual Conference**, Madurai Kamaraj University, Madurai, February 27-28, 2015.
2. Sundararajan S, Raghumaran S, Karthikeyan R, Asim A. Pattanayak, Kamalakannan B, Karuppasamy K, “*Comparative study of physico-chemical parameters in Gulf of Mannar and Palk-Bay, southeast coast of India*”, **Recent Trends in Modern Biology & 46th Aqua-Terr Annual Conference**, School of Biological Sciences, Madurai Kamaraj University, Madurai, February 27-28, 2015.
3. Mobin Mathew, Venkatesan R, Kulkarni S M Prasad Punna, “*Modeling and Analysis of a composite Instrument housing for off-Shore Data Buoys*”, **Fourth International Conference on Natural Polymers and Biomaterials**, ICNP 2015, April 10-12, 2015.
4. Pranesh S.B, Sathianarayanan D, Chandrasekar E, Murugesan M, Ramadass G.A, Atmanand M.A, “*Design and development of polypropylene frame for remotely operated vehicle*”, **OCEANS 2015**, May 18-21, 2015.
5. Vimala J, Latha G, Venkatesan R, “*Implementation and validation of wave algorithm in indigenized buoy system*”, **International conference on Industrial instrumentation and control (ICIC)**, College of Engineering Pune, India. May 28-30, 2015.
6. Kiran A.S, Vijaya R, Sivakholundu K.M, “*Stability analysis and design of offshore submerged breakwater constructed using sand filled geosynthetic tubes*”, **Procedia Engineering, Elsevier, 8th International Conference on Asian and Pacific Coasts (APAC 2015)** Vol. 116, 2015, pp. 310–319, IIT Madras, Chennai, September 7-10, 2015.
7. Sireesha N, Chithra K, Tata Sudhakar, “*Performance analysis of linear recursive least squares adaptive filter to mitigate multipath effect*”, **Proceedings of IEEE International Symposium on Ocean Electronics, Cochin University of Science & Technology, Kochi, India, SYMPOL 2015**, November 18-20, 2015.



8. Kannan R, Latha G, Prasanthi Devi M, "*Optimum statistical gridding technique for Multibeam Echosounder data processing*," **Proceedings of IEEE International Symposium on Ocean Electronics, Cochin University of Science & Technology, Kochi, India, SYMPOL 2015**, November 18-20, 2015.
9. Sridhar P.S.S.R, Malarkodi A, Nithyanandam K, Latha G, "*Development of directivity measurement system for underwater acoustic transducers*" **Proceedings of IEEE International Symposium on Ocean Electronics, Cochin University of Science & Technology, Kochi, India, SYMPOL 2015**, November 18-20, 2015.
10. Kiran K, Najeem S, Latha G, "*Development of Directivity Measurement System for Underwater Acoustic Transducers*" **Proceedings of IEEE International Symposium on Ocean Electronics, Cochin University of Science & Technology, Kochi, India, SYMPOL 2015**, November 18-20, 2015.
11. Sayanthi Bardhan, Jacob S, "*Experimental observations of direction of arrival estimation algorithms in a tank environment for sonar applications*", **Proceedings of IEEE International Symposium on Ocean Electronics, Cochin University of Science & Technology, Kochi, India, SYMPOL 2015**, November 18-20, 2015.
12. Senthilkumar P, Murugesh P, Jagadeesh Kadiyam, Venkatesan R, "*Corrosion and Bio-Fouling Study in Moored Buoy System*", **23rd Annual International Corrosion Conference and Expo, CORCON 2015, Chennai**, November 19–21, 2015.
13. Pankaj V, Vishnu Priya P, Vijaya Raghavan R, Dharani G, Kirubakaran R, "*Bacterial diversity and bio-prospecting in deep-sea sediments of Bay of Bengal and Barren Island in Andaman Sea*", **International symposium on dynamics of the Indian Ocean: Perspective and retrospective**, NIO, Goa, November 30 - December 4, 2015.
14. Simi Mathew, Usha Natesan, Latha G, Venkatesan R, "*Down welling Rossby wave with intense barrier layer precedes warming of the seas and interruption of warming of Arabian Sea warm pool by the high turbulent mixing*" **International Indian Ocean Expedition 2, NIO, Goa**, November 30–December 4, 2015.
15. Simi Mathew, Venkatesan R, Samar Kumar Ghose, Swain D, Vengatesan G, "*Role of net heat flux terms in warming the Bay of Bengal and Arabian Sea as observed from an insitu platform*", **International Indian Ocean Expedition 2, NIO, Goa**, November 30 –December 4, 2015.

16. Ramesh Kumar M.R, Rachel T Pinker, Simi Mathew, Venkatesan R, “*Evaluation of Radiative fluxes over North Indian Ocean*”, **International Indian Ocean Expedition 2, NIO, Goa**, November 30 – December 4, 2015.
17. Dipanjan Chaudhuri, Venkatesan R, Sundar R, Ravichandran M, Eric D'Asaro, Suneet Dwivedi, Mitra A.K, Jai Sukhatme, Debasissen gupta, “*Response of the Bay of Bengal to cyclone Phailin*”, **International Indian Ocean Expedition 2, NIO, Goa**, November 30 – December 4, 2015.
18. Raju V S Jampana, Ravichandran M, Dinesh K, Sudheer Joseph, Sundar R, Debasis Sengupta. “*On the stratification and mixing in the upper surface layer using moored buoys in the northern Bay of Bengal*”, **International Indian Ocean Expedition 2, NIO, Goa**, November 30 – December 4, 2015.
19. Balaji Chandrakanth, Venkatesan G, Purnima Jalihal, Iniyan S, “*Optimization of Shell and Tube Condensers - a Review on the Recent Research*”, **International Conference INDIA-APDA Conference 2016, Chennai**, February 11 - 13, 2016.
20. Prakash Kumar LSS, Venkatesan G, Samson Packiaraj Raphael, Purnima Jalihal, Iniyan S, “*Effect of Non Condensable Gas on Thermal Performance of Desalination System*”, **International Conference INDIA-APDA Conference 2016, Chennai**, February 11 - 13, 2016.
21. Nagasamy D, Prakash Kumar LSS, Prasad Dudhgaonkar, Purnima Jalihal, “*Process Optimization of a Laboratory based Integrated Energy Desalination Systems (IEDS)*”, **International Conference INDIA-APDA Conference 2016, Chennai**, February 11 - 13, 2016.
22. VijeshJayan, Vijayakumar M, Vinai Krishnan R, Sendhil Kumar Natarajan, Venkatesan G, NarendraRajagopalan, “*Theoretical Analysis of Seawater Desalination based on LTTD Vacuum method using Low Concentration Fresnel Lens CSP System*”, **International Conference INDIA-APDA Conference 2016, Chennai**, February 11 - 13, 2016.
23. Samson Packiaraj Raphael, Venkatesan G, Purnima Jalihal, “*Development and Validation of Matlab code for MEE-TVC Process*”, **International Conference INDIA-APDA Conference 2016, Chennai**, February 11 - 13, 2016.



24. Kavin Keerthy Vinayagam J.S, Venkatesan G, Prakash Kumar LSS, Purnima Jalihal, "*Mathematical Modelling and Performance Analysis of a Single Slope Solar Still*", **International Conference INDIA-APDA Conference 2016, Chennai**, February 11 - 13, 2016.
25. Venkatesan G, Prakash Kumar, Purnima Jalihal, "*Computational investigations of curved vane demister used in seawater desalination*", **International Conference INDIA-APDA Conference**, Chennai, February 11 - 13, 2016.
26. Balaji.D, Phani Kumar S.V.S, Ramana Murthy M.V, "*Energy destruction analysis of surface condenser of LTTD plant, Clean India Technologies: Role of Desalination and Water Purification*", **INDA-APDA Conference 2016, Chennai, India**, February 11-13, 2016.
27. Balaji.D, "*A Taguchi approach for the design optimization of deep sea water cooled shell and tube condenser of LTTD plant using HTRI, Clean India Technologies: Role of Desalination and Water Purification*", **INDA-APDA Conference 2016, Chennai, India**, February 11-13, 2016.
28. Chowdhury T, Pranesh S.B, Sathianarayanan D, Ramadass G.A, "*Development of a hyperbaric test system based on ASME boiler and pressure vessel code*", **International Conference on Materials, Design and Manufacturing Process, ICMDM**, February 17-19, 2016.
29. Simi Mathew, Venkatesan R, Usha Natesan, Latha G, "*Intense Convective Activity over northern Bay Of Bengal during late southwest Monsoon*", **AGU-OCEANS International Conference, New Orleans USA**, February 21-26, 2016.
30. Kiran A.S, Prince P.J, Vijaya R, "*Detached segmented submerged breakwater made of geosynthetic tubes for Kadalurperiyakuppam coast, Tamilnadu: A sustainable shoreline management solution*", **1<sup>st</sup> International conference on disaster mitigation and management for sustainable development and risk reduction (ICDMSDR 2016)**, NIT Tiruchirappalli, February 22-24, 2016.

## National Conferences

1. Jeyaraj N, Sathish T, Rajaguru S, Anburajan L, Vinithkumar N.V, Dharani G, Kirubakaran R, **National Seminar on Harmonizing Biodiversity and Climate change: Challenges and Opportunity**, Port Blair, April 17-19, 2015.
2. Sayanti Bardhan, Dhilsha R, Jacob S, "*Colour Quantized Imaging for Indigenous Sonar System*", **National Hindi Scientific Seminar, ESSO Indian National Centre for Ocean Information Services**, Hyderabad, September 28-29, 2015.
3. Dhilsha R, Sayanti Bardhan, Sreedev D.S, Zakharia S, Eldhose M, Jacob S, Atmanand M.A, "*Performance of Beamforming Algorithms to detect Buried Objects in seabed*", **National Symposium on Acoustics, NSA-2015** "Acoustic for Ocean Environment", NIO Goa, October 7-9, 2015.
4. Mahanty M.M, Latha G, Edwards Durai P, "*Biological soundscapes of shallow water in the southeastern Arabian Sea*", **National Symposium on Acoustics, NSA-2015** "Acoustic for Ocean Environment", CSIR-NIO Goa, October 7-9, 2015.
5. Kannan R, Latha G, Nithyanandam K, "*Fluctuation and variability of ambient noise off Kakinada*", **National Symposium on Acoustics, NSA-2015** Goa "Acoustic for Ocean Environment", CSIR-NIO Goa, October 7-9, 2015.

## Nucleotide Sequence submitted in gene bank

Sl. No.	Authors	No. of Sequences
1.	Jayappriyan, K.R., Dheenan, P.S., Sathish, T., Baskar, B., Vinithkumar, N.V., Dharani, G. and Kirubakaran, R.	8
2.	Dheenan, P.S., Jayappriyan, K.R., Begum, M., Vinithkumar, N.V., Dharani, G. and Kirubakaran, R.	11
3.	B. Meena, L. AnbuRajan, N. V. Vinithkumar, G. Dharani and R. Kirubakaran	20
4.	M. K. Rasheeda, R. Sendhil Kumar, G. Dharani and R. Kirubakaran	27
5.	M. K. Rasheeda, R. Sendhil Kumar, G. Rajaprabhu, G. Dharani and R. Kirubakaran	2
6.	Karthikeyan,V., Damotharan,P., Satheeswaran,T.,Yuvaraj,P.,Chandradeep,P., DilipKumar,J.,Dharani,G., Balasubramanian,T. and Kirubakaran,R.	2
7.	Revathi,K., Vidhya,G., Srividhyalakshmi,V. and Kirubakaran,R.	11
8.	Saravanan,N., Verma,P., Sendhilkumar,R., LimnaMol,V., Dharani,G.andKirubakaran,R.	4



## INVITED TALKS

### **Dr.S.S.C.Shenoi**

- A lecture on "Operational Oceanographic Services in India" during SERB School Training Programme at Centre for Atmospheric Sciences, Indian Institute of Technology, Delhi on May 30, 2015.
- Invited talk at the annual Climate Change Workshop and make a presentation on the topic "Science of Indian Ocean Climate Variability and Change" at National Centre for Earth Science Studies, Trivandrum on August 19, 2015.
- Invited talk at the National Conference entitled, " National Conference on Exploration of Computation and Information Technology for Disaster Management (ECITDM15)" as Chief Guest and deliver the Inaugural/Presidential speech at Adhiyamaan College of Engineering, Hosur, Tamilnadu on September 10, 2015.
- Invited talk at the inaugural session and deliver a keynote speech on Ocean Information and Services during Silver Jubilee Celebrations of the Centre for Ocean Electronics, Cochin University of Science & Technology, Kochi on February 26, 2016.
- Invited talk at the National Workshop on Capacity-building for the Implementation of the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (SSF Guidelines) at India International Centre, New Delhi organized by International Collective in Support of Fishworkers (ICSF) in collaboration with World Forum of Fisher Peoples (WFFP) and World Forum of Fish Harvesters & Fish Workers (WFF) on March 21, 2016.

### **Dr.Purnima Jalihal**

- Invited talk at SRM University, Kattankulathur on "Structural and Offshore Design Challenges in Thermal Desalination Systems", July 25, 2015.
- Invited talk at the Institute of Engineers organized by Railways / IEEE / IET, Delhi on "Ocean Thermal Energy Conversion – Status & Complexities", September 29, 2015.
- Invited talk on "Energy & Water from the Oceans – New Initiatives" on February 12, 2016 and at InDA-APDA Conference 2016, Chennai on "Clean India Technologies – Role of Desalination and Water Purification".

**Dr.M.V.Ramana Murthy**

- Invited talk at Workshop on Coastal Zone Management, IIT Madras, Chennai on “Ocean Recourses-ICZM perspective”, April 18, 2015.
- Invited talk at the Fundamentals of Oceanic Processes and Modelling, SERB School, IIT Delhi, New Delhi, on “Ocean processes and its impact on off-shore structures”, May 19 to June 11, 2015.
- Invited talk at the Workshop on EU-India Joint R&D Platform to support Offshore Wind in India, NIWE, Chennai on “NIOT's efforts towards assessing the potential for offshore energy production and synergies for Offshore Wind”, September 18, 2015.
- Invited talk at the Workshop MNRE, New Delhi on “Development of India's Offshore Wind Industry”, March 22, 2016.

**Dr.R.Venkatesan**

- A lecture on "IEEE- Sri SaiRam institute technical and engineering conglomeration", at Sri Sairam Institute of Technology, July 2, 2015.
- A lecture on “Ocean law and governance – an overview”, at IIT Kharagpur, March 16-18, 2016.

**Dr.R. Kirubakaran**

- Invited talk at HEL Process Development Conference and Workshop, HEL India, Goa, February 25-26, 2016.
- Invited talk at the National Conference on Phytochemicals as Biotherapeutics – Unravelling the Mystery of Natural Products (HERBESCON 2016). Sri Ramachandra University Chennai, February 17, 2016.
- Invited talk at the Symposium cum Workshop on “Advances in Life Science and Bioprospecting of Marine Resources. Hindustan College of Arts & Science, Chennai February 4, 2016.
- Invited talk at the National Consultation Meeting on Pharmaceuticals and Bio-fuel from Marine Biological Systems - Status, Constraints and Way Forward, Cochin University of Science and Technology on “Mass scale cultivation of marine microalgae for biofuel production”, February 1-2, 2016.
- Invited talk at the ASEAN-India Marine Biotechnology Project Formulation Workshop. CSIR-National Institute of Oceanography, Dona Paula, Goa on “Marine biotechnological tools for bioremediation”, August 17, 2015.





### **Dr.Dhilsha Rajapan**

- Invited talk at Vellore Institute of Technology (VIT), Vellore on “Marine sensors & Systems”, April 2015.
- Invited talk at the Indian Institute of Information Technology, IIIT D&M, Kancheepuram, Vandalore on “Sensors & Systems for Oceanographic applications”, February 2016.
- Invited talk at the IEEE International Symposium on Ocean Electronics (SYMPOL), Cochin University of Science & Technology, Kochi on “Acoustic Imaging and Synthetic Aperture Sonar”, November 20, 2015.

### **Dr.G.Latha**

- Invited talk at the National Symposium on Acoustics, Goa on “Time series observations of ocean ambient noise for acoustical oceanographic applications”, October 7-8, 2015.
- Lectures on “Passive acoustic measurement systems, data analysis and applications” for the Ocean acoustics course, at the Department of Ocean Engineering, IIT Madras, March 2016.

### **Mr.D.Rajasekhar**

- Inaugurated the National Conference conducted by Velammal Engineering College, Chennai & delivered the Key Note Address.
- Invited talk at the Institute of Marine Engineers-Chennai Chapter on 'Super long stroke Diesel Engines'.
- Invited talk at Institute of Marine Engineers-Chennai Chapter on 'Time management'.
- Invited talk at AMET University on 'Underwater mapping'.
- Participated in 'Panel discussions in International/National conferences conducted by Institute of Engineers'.

### **Dr.Vijaya Ravichandran**

- Invited talk at the 'Theme Meeting on Cooling Water Treatment for Biofouling Control Technical Program, organized by Biofouling & Biofilm Processes Section, (Water and Steam Chemistry Division), DAE-COSWAC on “Environmental Impact Assessment (EIAs) for marine intake / outfall”, April 23, 2015.
- Invited talk on “CZM and regulations”, as part of 5-day short term training programme on Design of coastal and Offshore structures organised by Department of Civil Engineering, Andhra University, College of Engineering, February 1-5, 2016.

**Dr. Basanta.Kumar Jena**

- A lecture on “The formation of the Coromandel coastal environment, its eco-system; present threats coastal conflicts and coastal management”, at Calibre International School, Mylapore as part of International School Award Activity, September 4, 2015,.
- Invited talk at INCOIS Data Awareness Workshop for the students from IIT, Bhubaneswar on “HF radar data applications and its analysis”, December 8-11, 2015.
- An inaugural talk as a Chief Guest in the “National Conference on Coastal Environment – 2015” on October 29-30, 2015” at Sathyabama University, Chennai, Tamil Nadu, India.

**Dr.G.Venkatesan**

- Invited talk at the Bhabha Atomic Research Centre, Kalpakkam, on account of World Water Day Celebration 2016 on “Energy Recovery and Sustainable Development”, March 20, 2016.
- Invited talk at SSN College of Engineering, Kalavakkam on “Potential Research Activities in Ocean Energy and Desalination”, February 26, 2016.
- Invited talk at Bangalore Institute of Technology, Bangalore on “Application of Solar Energy for seawater desalination”, October 27, 2015.
- Invited talk at SRM University, Katankulathur (as a part of their curriculum for UG) on “System Design and Parametric Analysis for Desalination of Sea water (LTTD)”, July 25, 2015.
- Invited talk during the Inauguration of International conference on recent advancement in mechanical Engineering and Technology, AVIT, Kancheepuram district on “Research issues and challenges in Ocean technology”, April 23, 2015.

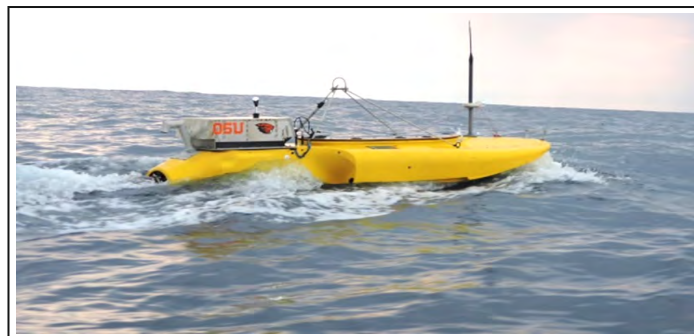


## BILATERAL COLLABORATION

### ○ **ASIRI-Air-Sea Interaction Research Initiative**

Air-Sea Interaction Research Initiative and Ocean Mixing and Monsoon Experiment (ASIRI-OMM) project is a collaborative program with USA. This program aims to improve the understanding and prediction of monsoon systems through the study of air-sea fluxes and upper ocean processes in Bay of Bengal. The project also focuses on the effects of Bay of Bengal freshwater flux on Indian Ocean Monsoon and persistence of strong stratification in the northern Bay of Bengal.

The ASIRI-OMM team presented the preliminary results including the two posters by NIOT at the International Symposium on Indian Ocean held at NIO, Goa during December, 2015. Intense convective activity over northern Bay of Bengal estimated using buoy data is presented in the special session for ASIRI-OMM project at AGU-OCEANS in February 2016 in New Orleans, USA.



*Remotely Operable Boat*



*Joint operation – ORV Sagar Nidhi and US vessel Roger revell*

- **Memorandum of Understanding signed between NIOT & IST Portugal for mutual collaboration in Ocean Science and Technology.**

## DEPUTATION ABROAD

Sl. No.	Name of the officer	Countries Visited	Programme under visit	Period
1.	Dr. A.Ganesh Kumar	Colombo, Sri Lanka	Participated in Research Cruise “Arabian Sea Monsoon” Colombo, Sri Lanka to Mumbai, India, International Ocean Discovery Program Expedition 355 in JOIDES RESOLUTION	31 <sup>st</sup> Mar to 31 <sup>st</sup> May 2015
2.	Dr.M.A.Atmanand	Genova, Italy	To attend conference on Oceans '15 held at Genova, Italy and visit to OGS, Trieste. Main travel for conference part funded by sponsors.	16 <sup>th</sup> to 24 <sup>th</sup> May 2015
3.	Dr.Purnima Jalihal	KASSEL, Germany	To attend workshop on Ocean Energy and 28th Ex-Co meeting of IEA – OES at KASSEL, Germany	11 <sup>th</sup> to 13 <sup>th</sup> May 2015
4.	Dr.R.Venkatesan	Dartmouth, USA	To attend Indo-US research programme “Coupled physical processes in the Bay of Bengal and monsoon air-sea interaction” organized by University of Massachusetts	26 <sup>th</sup> to 28 <sup>th</sup> May 2015
5.	Dr. N.V.Vinith Kumar	Colombo, Srilanka	To attend Coastal Hazard Assessment : Applications in Risk Assessment, Management and mitigation	2 <sup>nd</sup> to 5 <sup>th</sup> June 2015
6.	Shri G.Venkatesan	Aston University, UK	To attend investigations on a single stage flash evaporative desalination system using condenser reject heat	13 <sup>th</sup> to 22 <sup>nd</sup> June 2015
7.	Dr.M.A.Atmanand	UNESCO Hqr. Paris, France	To attend 48th session of the International Oceanographic Commission (IOC) Executive Council and the IOC Science Day of UNESCO at Paris.	15 <sup>th</sup> to 26 <sup>th</sup> June 2015
8.	Shri M.Arul Muthiah	University of Washington & M/s Kongsberg, Seattle, USA	To attend underwater glider training program	22 <sup>nd</sup> June to 3 <sup>rd</sup> July 2015



Sl. No.	Name of the officer	Countries Visited	Programme under visit	Period
9.	Mr.N.Ravi	Colombo, Sri Lanka	To take care of maintenance activities of hull mounted scientific and laboratory equipments, to supervise and to ensure the timely completion of the dry dock work of Sagar Nidhi at Colombo Dockyard PLC (CDPLC)	July to August 2015
10.	Mr.D.Narendrakumar			
11.	Mr.P.S.Deepak Sankar			
12.	Mr.V.Pandurangan			
13.	Mr.S.Siva Chidambaram			
14.	Mr.K.Ramasundaram			
15.	Mr.T.Babu			
16.	Mr.K.Nishath	Mauritius	To take care of operation & maintenance of scientific equipments onboard Sagar Nidhi, to liaise and to ensure the timely completion of all the activities for successful / smooth execution of IIOE cruise.	
17.	Mr.V.Pandurangan			
18.	Mr.S.Siva Chidambaram			
19.	Mr.K.Nishath			
20.	Mr.P.Nagendra Sivakumar			
21.	Mr.Jenson.V.George	Arctic, Norway	To retrieve and re-deployment of IndARC moored observatory system	9 <sup>th</sup> to 20 <sup>th</sup> July 2015
22.	Mr.Kesavakumar			
23.	Mr.Muthukumar		New Arctic observatory (Ind ARC II) additional biogeochemical sensors& acoustic sensors was deployed successfully by NIOT-OOS / OA team along with NCAOR	
24.	Mr.Gowthaman			
25.	Mr.Gnanadhas			
26.	Mr.P.Ramesh			
27.	Mr.A.Thirunavukkarasu			
28.	Mr. G.Raguraman	Geneva, Switzerland	To attend 31st Session of Joint WMO-IOC Data Buoy Cooperation Panel and 35 <sup>th</sup> meeting on Argos Joint tariff Agreement at WMO Headquarters, Geneva	19 <sup>th</sup> to 28 <sup>th</sup> October 2015
29.	Dr.R.Venkatesan			
30.	Dr.R.Venkatesan	Colombo, Sri Lanka	Regional Exercise & workshop on oil spill preparedness and Response in Colombo, Srilanka	2 <sup>nd</sup> to 6 <sup>th</sup> November 2105
31.	Dr.S.S.C.Shenoi	Guangzhou, China	To attend the 1 <sup>st</sup> Indo-China Joint workshop seminar meeting for cooperation on marine science and technology	14 <sup>th</sup> to 18 <sup>th</sup> December 2015

Sl. No.	Name of the officer	Countries Visited	Programme under visit	Period
32.	Mr.S.Najeem	Mauritius	To participate in the First expedition of IIOE-2 onboard ORV Sagar Nidhi from Goa to Mauritius of Ocean Acoustics programme, Ocean ambient noise measurements were made in deep waters to study the characteristics for acoustic oceanographic applications.	4 <sup>th</sup> to 24 <sup>th</sup> December 2015
33.	Dr.R.Kirubakaran	New York, USA	To attend the meeting of Preparatory Committee to formulate an agreement on the issue of Marine Biological Diversity beyond the areas of National Jurisdiction.	30 <sup>th</sup> March to 8 <sup>th</sup> April 2016





## MEMBERSHIP IN COMMITTEES

### **Dr. S.S.C. Shenoi**

Member/chair of several national and international committees

- Early Career Scientists Award Committee of the International Union of Geodesy and Geophysics (IUGG)
- Sectional Committee of Indian Academy of Science on Earth & Planetary Sciences
- Executive Committee of International Association for Physical Sciences of Ocean (IAPSO)/IUGG
- Editorial Board of Indian Journal of Geo-Marine Sciences, Current Science
- Research Advisory Committee of C-MACS, Bangalore
- Steering Group of Intergovernmental Coordination Group of Indian Ocean Tsunami Warning Services (ICG/IOTWS)
- Indian Delegation to IOC Executive Committee and General Assembly, etc.

Co-chairs

- Steering Committee for International Indian Ocean Expedition-2 (IIOE-2) established by Intergovernmental Oceanographic Commission (IOC/UNESCO)
- Scientific Committee on Oceanic Research (SCOR) and Indian Ocean Global Ocean Observing System (IOGOOS)
- National Vice-President of Vijnana Bharati, India and Vice-president of Indian Geophysical Union.

### **Dr.M.A. Atmanand**

- Founding Chairman of IEEE Oceanic Engineering Society in India.
- Senior Member of IEEE.
- Life Member of Ocean Society of India (OSI).
- Fellow of Institution of Engineers (India).
- Chair Elect Madras Chapter (2015).
- Associate Editor of IEEE Journal of Oceanic Engineering.
- Member of Society of Underwater Technology (SUT).
- Member of Marine Technology Society (MTS).
- Associate Editor of IEEE Journal of Oceanic Engineering
- Member of Technology Research Board of Ministry of Earth Sciences, Govt. of India (till July 2015)
- Member of Research Advisory Council of National Institute of Oceanography (CSIR – NIO) (till July 2015).

- Member of Naval Research Board (till July 2015).
- Member of Governing Council of Jerusalem College of Engineering.
- Member of Governing Council of Indian National Centre for Ocean Information Services (INCOIS), Hyderabad (till July 2015).
- Member of Governing Council of National Centre for Antarctic and Ocean Research (NCAOR).
- Member of Lab Research Council at NSTL, Visakhapatnam.

#### **Dr.Purnima Jalihal**

- Member, Programme Advisory Committee - Water Technology Initiative, Dept. of Science & Technology.
- Expert Member of RD&D Project Appraisal Committees (RDPACs) for Appraisal of RDD&D proposals for the Development of Ocean Energy in India at Ministry of New and Renewable Energy, New Delhi.

#### **Dr.R.Venkatesan**

- Steering Committee Member (Asia/Oceania) of Global Ocean Observation System (GOOS) of UNESCO IOC Paris nominated by Government of India.
- India is represented in Data buoy cooperation panel by NIOT. Dr.R.Venkatesan elected as Vice chairman for Asia in the meeting held at WMO Headquarters, Geneva, Switzerland during 19<sup>th</sup> – 28<sup>th</sup> October 2015.
- Chair of international Tsunameter Partnership and Chair of Working group on Vandalism and is member of Indian Ocean Buoy programme and Moored buoy task force.
- Chairman for IEEE Oceanic Engineering Society India Chapter.
- National Consultant on Oil spill contingency plan for SACEP –NORAD- IMO project nominated by Government of India.
- Chairman of Marine materials committee of Marine Technology Society USA.
- Chairman for the Marine Technology Society (MTS) India Section.

#### **Dr.M.V.Ramana Murthy**

- Member, "Expert Appraisal Committee of CRZ, Infrastructure & Miscellaneous and New Construction and Industrial Estates Projects".
- Member, Pondicherry Coastal Zone Management Authority
- National Experts, "Constitution of Panel of Experts, Climate Resilient Protection and Management Project, CWC
- Member, Bureau of Indian Standard, on Cyclone Resistant Structures Sectional





Committee, (CED-57)

- Member, National Coastal Zone Management Authority, NCZMA.
- Member, Task Force Committee for Coastal erosion works, Gujarat.

**Dr. G.A. Ramadass**

- Member, IEEE Oceanic Engineering Society

**Dr. R. Kirubakaran**

- Member – Secretary of National Task Force for Ballast Water Management.
- Member of QRC, Central Institute of Brackishwater Aquaculture, Chennai.
- Member for selection of sites to establish National Institute of Marine Biology and Biotechnology jointly by the DBT and MoES
- Member, National Task Force, The Bay of Bengal Large Marine Ecosystem.
- Member, Project Review Board, Naval Materials Research Laboratory, Ambernath.
- Member, Board of studies for M.Sc. Marine Biology, Pondicherry University.
- Member, Board of studies for M.Sc. and Ph. D. Marine Biology, Alagappa University.
- Member, Research Advisory Council, Marine Bio-Resource Centre, Jamnagar.
- Member, Inter-Departmental Committee on Marine Bio-prospecting and Bio-energy, Department of Biotechnology, Government of India.
- Member, Coastal Aquaculture Authority of India.
- Research Supervisor and Member of Doctoral Committee, Sathyabama University
- Member of Doctoral Committee, SRM University and Sri Ramachandra University
- Recognized Research Guide, Anna University
- Life Member, Indian Science Congress Association
- Life Member, Society for Reproductive Biology and Comparative Endocrinology
- Life Member, Association for DNA finger printing and related technologies.
- Life Member, Ocean Society of India.
- Member, Task Force Committee for Aquaculture and Marine Biotechnology, Department of Biotechnology, Government of India.
- Member, Research Advisory Committee of Gulf of Mannar Biosphere Reserve Trust.

**Dr. Dhilsha Rajapan**

- Member, Acoustic Society of America
- Member, IEEE Oceanic engineering society, India chapter
- Member, IEEE/UFFC Society
- Life Member, Acoustic Society of India

- Life Member, Magnetic Society of India.
- Doctoral Committee Member, Anna University, Chennai.
- PhD, Viva Voce Examiner, SSN College, Anna University, Chennai.
- National Committee Member PDR of DRDO project, NSTL, Vizakhapatnam, September 2015.

### **Shri D.Rajasekhar**

- Member Secretary, Joint Scientific and Technical Advisory Committee.
- Expert Member in Ship acquisition-GSI.
- Expert Member for acquisition of Polar Research Vessel and Three new Research Vessels for NCAOR/MoES.
- Member Secretary, Project Monitoring and Coordination Committee-Acquisition of Two CRVs for NIOT/MoES.
- Chairman, Staff Welfare Committee, NIOT.
- Member in Technical Evaluation Committee (TEC) for Construction of India's Third Antarctic Station Bharati in Antarctica.
- Expert Member of Ship Acquisition Committee of Tamil Nadu State Fisheries Department.

### **Dr.G.Latha**

- Member, Acoustic Society of America.
- Member, IEEE Signal Processing Society.
- Member, Local Council of Indian Meteorological Society - Chennai Chapter.
- Member, Doctoral Committee, Anna University.
- Member, Doctoral Committee, Vellore Institute of Technology.
- Member, Doctoral Committee, Sathyabama University, Chennai.
- Life Member, Ocean Society of India.
- Co-opted Member of Science and Engineering Research Board, Government of India.

### **Dr.Basanta Kumar Jena**

- American Geophysical Union (AGU), Florida Avenue N.W, Washington, DC 20009-1277 USA
- Associate Member at ASCE, USA, American Society of Civil Engineers
- Member the Board of Governors of the Coasts, Ocean, Ports, and Rivers Institute, USA





- Life Member, Ocean Society of India.
- Society Member, Coastal Education & Research Foundation, Inc. (CERF), official publisher of the Journal of Coastal Research (JCR).
- Secretary for Ocean Society of India (OSI), Chennai Chapter.
- Joint Secretary of Ocean Society of India (OSI) since June 2014.

**Dr. Vijaya Ravichandran**

- Member, EAC, Nuclear and Defence Projects. Ministry of Environment and Forests, Govt. of India.

**Dr. S. Ramesh**

- Member, IEEE Oceanic Engineering Society.
- Life Member, Ocean Society of India.

**Cdr Gopkumar Kuttikrishnan**

- Fellow, The Institution of Engineers (India).
- Member, The Institute of Marine Engineers (India).
- Senior Member, Indian Institution of Industrial Engineering.
- Member, Society of Automotive Engineers (India).

**Dr. S. V. S. Phani Kumar**

- Member, IEEE-Ocean Engineering Society (IEEE-OES).
- Member, Indian Desalination Association (InDA).
- Member, Ocean Society of India (OSI).

**Mr. N. Vedachalam**

- Marine Technology Society.
- Society for Underwater Technology.
- International Society of Offshore and Polar Engineers, IEEE OES.

**Mr. N. R. Ramesh**

- Member, IEEE Oceanic Engineering Society.
- Life Member, Ocean Society of India.
- Mining Engineers Association of India.
- Life Member, National Institution for Quality and Reliability.
- Member, Madras Management Association (MMA).

**Mr. S.Muthukrishna Babu**

- Member, IEEE OES, India chapter.
- Member, OSICON, India.

**Mr. P. Muthuvel**

- Secretary & Member, IEEE OES, India Chapter.
- Member, OSICON, India.

**Mr. AN. Subramanian**

- Member, IEEE OES.
- Institute of Engineering (AIME).
- Indian Society for Technical Education (MISTE).

**Dr. G. Dharani**

- Member, Professional Association of Diving Instructors.
- Member, Doctoral Committee, SRM University.
- Member, Doctoral Committee, Anna University.
- Member, Doctoral Committee, Sathyabama University.
- Life Member, Ocean Society of India.

**Mr.M.Sankar**

- Life Member, Ocean Society of India.
- Member, IEEE OES, India Chapter.

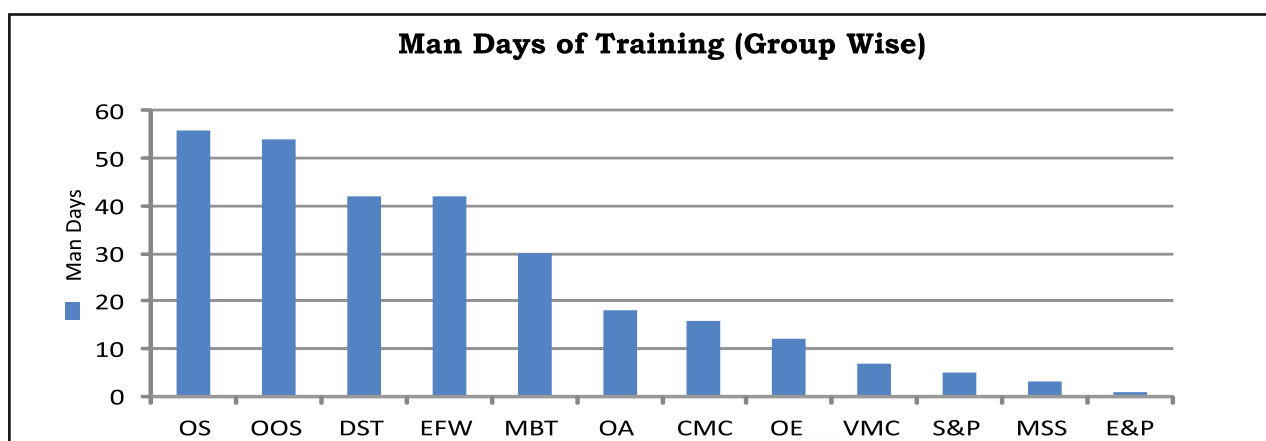
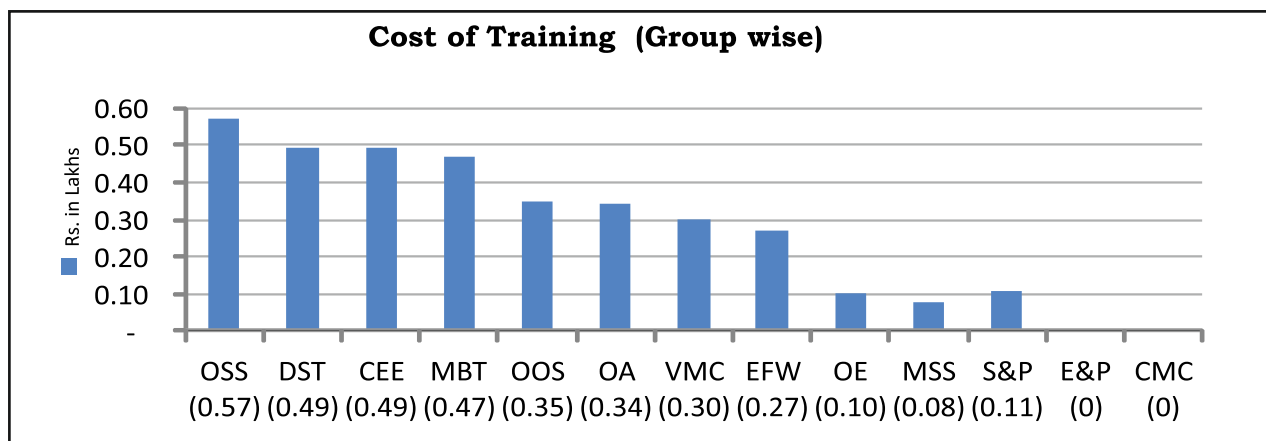


## HUMAN RESOURCE DEVELOPMENT

The section organizes training courses in the areas of engineering, 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 provides both short term (4 weeks to 6 months) and long term (one year or so) project training to students pursuing M. Tech or their equivalent degree programmes, at different educational institutions spread over the country in the field of ocean technology to fulfil their academic degree requirements. The project topics are ensured to bring value addition to NIOT activities from the student community. During April 2015 to March 2016, 88 students have carried out their project works in various departments of NIOT. Short term internships (minimum 2 weeks maximum 4 weeks) for 95 UG Students were also arranged during the summer and winter vacation.

With regards to the staff external training, the section has coordinated trainings cumulating about 370 man-days costing about Rs.3.5 Lakhs. The section-wise break up is shown in the following graphs:



### Training/workshop underwent by NIOT Scientists and Technical Staff

Sl. No.	Name of the Staff	Training Programme	Conducted by	Duration
1.	Mr. D. Rajasekhar	Advanced Workshop on CFD based Optimization	Bangalore	14 <sup>th</sup> May 2015 (1 day)
2.	Mr. B. Nanda Kishore	Fundamentals of Oceanic Process and Modelling	IIT Delhi	19 <sup>th</sup> May to 11 <sup>th</sup> June 2015 (23 days)
3.	Dr. S V S Phani Kumar	Numerical Ocean Hydrodynamics	IIT Kharagpur	8 <sup>th</sup> to 13 <sup>th</sup> June 2015 (6 days)
4.	Mr. Sridhar Muddada			
5.	Mr. A. A. Gnanaraj	Changes In ASME Boiler & Pressure Vessel Code 2015	The Westin, Chennai	30 <sup>th</sup> June 2015 (1 day)
6.	Mr. Pranesh			
7.	Mr. Bolem Srinivas	Virtual Reality Course	IIT Madras, Chennai	13 <sup>th</sup> to 24 <sup>th</sup> July 2015 (12 days)
8.	Mr. M. Radha Krishnan	Use of Physical Simulations in Materials Research	IIT Madras, Chennai	17 <sup>th</sup> to 18 <sup>th</sup> July 2015 (2 days)
9.	Dr. S. Sundarrajan	Current Requirements in Environmental Impact Assessment (EIA) Process and Procedures	National Institute for Micro, Small and Medium Enterprises (NI-MSME), Hyderabad	20 <sup>th</sup> to 22 <sup>nd</sup> July 2015 (3 days)
10.	Mrs. K R Anuradha	Right to Information Act, 2005	NIWE, Chennai	24 <sup>th</sup> July 2015 (1 day)
11.	Mrs. T. Latha			
12.	Mrs. A. S. Vijayalakshmi			
13.	Mrs. M. Vansi Philomena			
14.	Mr. S. Muthukumaravel	Workshop on Wavlets for Image Processing	IEEE Madras Section, Chennai	6 <sup>th</sup> to 7 <sup>th</sup> August 2015 (2 days)
15.	Mr. P. Thangarasu			



Sl. No.	Name of the Staff	Training Programme	Conducted by	Duration
16.	Mr. M. Sankar	Multidisciplinary Perspectives on Science, Technology and Society	National Institute of Advance Studies, Bangalore	10 <sup>th</sup> to 21 <sup>st</sup> August 2015 (12 days)
17.	Dr. G. Venkatesan	Science Administration and Management	ASCI, Hyderabad	17 <sup>th</sup> to 28 <sup>th</sup> August 2015 (12 days)
18.	Dr. S. Ramesh			
19.	Dr. Tamshuk Chowdhury	E-Foundry: Dasting Design and Simulation	Anna University, Chennai	20 <sup>th</sup> to 21 <sup>st</sup> August 2015 (2 days)
20.	Dr. A. Ganesh Kumar	Laboratory Management System & Internal Audit as per ISO / IEC 17025:2005	Chennai	20 <sup>th</sup> to 23 <sup>rd</sup> August 2015 (2 days)
21.	Ms. T. Sreelatha			
22.	Ms. Lakshmi Vijayakumar			
23.	Mr. S. Krishna Mohan	Contract Law and Management	Bengaluru	21 <sup>st</sup> to 23 <sup>rd</sup> August 2015 (3 days)
24.	Mr. Sanjay kumar	Hypack India 2015	Bogmalo, Beach Resort, Goa	24 <sup>th</sup> to 26 <sup>th</sup> August 2015 (3 days)
25.	Mr. Yogiraj Gosavi			
26.	Mr. R. Mohan			
27.	Mr. R. Srinivasan			
28.	Mr. C. R. Deepak	AICTE Sponsored Short Term Course Dynamic Analysis & Design of Ocean Structures	Chennai	21 <sup>st</sup> to 25 <sup>th</sup> September 2015 (5 days)
29.	Mr. Doss Prakash	Workshop on "Sensor Design and Analysis"	Hotel Raj Park, Chennai	11 <sup>th</sup> September 2015 (1 day)
30.	Mr. Subramanian R M	Deep Foundation Technologies for Infrastructure Development in India	IISc, Bangalore	28 <sup>th</sup> to 30 <sup>th</sup> September 2015 (3 days)

Sl. No.	Name of the Staff	Training Programme	Conducted by	Duration
31.	Mr. Yogiraj Gosavi	Training course on "Indian Ocean Dynamics from the Large Scale Circulation to small Scale Eddies and Fronts"	INCOIS, Hyderabad	16 <sup>th</sup> to 27 <sup>th</sup> November 2015 (12 days)
32.	Mr. Arunraj K S			
33.	Mr. Annapureddy P Reddy			
34.	Mr. G Raguraman	Laboratory Management System & Internal Audit	ETDC Center, Bangalore	16 <sup>th</sup> to 19 <sup>th</sup> November 2015
35.	Mr. Tata Sudhakar	Policy for Science and Science for Policies NISAR Science Workshop	NIAS, Bangalore	16 <sup>th</sup> to 20 <sup>th</sup> November 2015
36.	Dr. Basanta Kumar Jena			
37.	Mr. Jay Shankar Upadhyay	NISAR Science Workshop	SAC, Ahmedabad	19 <sup>th</sup> to 20 <sup>th</sup> November 2015
38.	Dr. Sridhar Muddada	Training Programme on Telemac	IIT Bombay, Mumbai	18 <sup>th</sup> to 19 <sup>th</sup> January 2016 (2 days)
39.	Mrs. Shyamala Varthini			
40.	Mr. Gummadi Anil Kumar			
41.	Mr. K. Prabhakaran	Training Programme on "Information & Network Security"	ERNET India Regional Centre, Chennai	22 <sup>nd</sup> to 23 <sup>rd</sup> January 2016 (2 days)
42.	Mr. Abu Jasim			
43.	Dr. Sanjana M C	NIAS-DST Training Programme for Women Scientist, "Science for Progress in India: Innovations in Technologies for Scientists and Technologist"	National Institute of Advance Studies, Bangalore	8 <sup>th</sup> to 12 <sup>th</sup> February 2016 (5 days)
44.	Ms. Sucheta Sadhu	Biotech Bioinfo Workshop	ICSCCB, Pune	20 <sup>th</sup> to 24 <sup>th</sup> February 2016 (5 days)



Sl. No.	Name of the Staff	Training Programme	Conducted by	Duration
45.	Dr. Jossia Joseph	Extreme Waves in Ocean Engineering	IIT Madras	21 <sup>st</sup> March to 1 <sup>st</sup> April 2016 (12 days)
46.	Mr. A. Aruna Kumar			
47.	Mr. Karunakar Kinatada			
48.	Dr. G. Dhinesh			
49.	Mr. K Mullai Vendhan			
50.	Mr. Abhijeet Sajjan			
51.	Dr. N V Vinith Kumar	Indo-French Planning Workshop	IISc., Bangalore	7 <sup>th</sup> to 9 <sup>th</sup> March 2016 (3 days)
52.	Dr. Benjamin Franklin	Workshop on Bioinformatics - Recent Advances in Genomics	RMRC, ICAR, Department of Health Research, Port Blair	28 <sup>th</sup> to 29 <sup>th</sup> March 2016 (2 days)
53.	Dr. T. Sathish			

### Extra Mural Lectures at NIOT

- “Good and Bad are not due to others”, was delivered by Mr. V. Viswanathan, Sri Sathya Sai Education in Human Values, TN on 18<sup>th</sup> June 2015.
- “Legal framework for exploration of resources in the ocean floor and beyond national jurisdictions”, was delivered by Mr. H. P. Rajan, Legal Advisor for Law of the Sea at Asian-African Legal Consultative Organization (AALCO) on 11th September 2015.
- “Yoga for Holistic Health”, was delivered by Dr. TKS Sekhar, Calm Trust Sky Yoga on 17<sup>th</sup> July 2015.



*Dr. Purnima Jalihal, Scientist – G, NIOT presented a memento to Mr. V. Viswanathan*

### Technical Lecture at NIOT

- A lecture on “Innovative approaches for Ocean Observation”, under the auspices of IEEE - OES India Chapter and Ocean Society of India (OSI)” was delivered by Prof. Gopu Potty, University of Rhode Island, USA on 26<sup>th</sup> November 2015 at NIOT, Chennai.



## SCIENTIFIC CRUISE PROGRAMS

### List of cruises undertaken during 2015-16

#### Sagar Nidhi:

User/Cruise	Activity
DST-NIOT	WACS trials
Indian Coast Guard	Search and Rescue operation of missing Dornier Aircraft
IISC/INCOIS	Ocean Mixing and Monsoon Cruise for multi-disciplinary studies in Bay of Bengal
OOS-NIOT/INCOIS	Ocean Data Buoy Operations for Ocean Observations
INCOIS	RAMA Moorings for monsoon analysis and prediction
IIOE-IISC/INCOIS/NCAOR	International Indian Ocean Expedition [IIOE-2] to understand the Dynamics of the Indian Ocean

#### Sagar Manjusha:

OOS-NIOT	Met ocean buoy operations for Ocean Observations
INCOIS	Wave Rider Buoy Deployment for weather prediction
MBT-NIOT	Drugs from Sea-CTD casting, Water, Grab & corer sampling
NCESS	COMAPS Programme for pollution monitoring along west coast of India
ICMAM	COMAPS Programme for pollution monitoring along Indian Coast
OE-NIOT	Testing of equipments
IIT-Madras	CTD casting, Water, Grab & corer sampling at Bay of Bengal
EEZ-NIOT	Geo Scientific Studies at East Coast of India
Madras University	Sampling programme
Annamalai University	COMAPS Programme for pollution monitoring along east coast of India

#### Sagar Purvi:

EEZ-NIOT	Geo Scientific Studies at East Coast of India
NCSCM	Sampling programme for coastal water studies
Annamalai University	COMAPS Programme for pollution monitoring along east coast of India
Pondicherry University	COMAPS Programme for pollution monitoring along east coast of India
NIO-Goa	COMAPS Programme for pollution monitoring along west coast of India
ICMAM	COMAPS Programme for pollution monitoring along Indian Coastal waters
NIO-Mumbai	COMAPS Programme for pollution monitoring along west coast of India
University of Hyderabad	COMAPS Programme for pollution monitoring along west coast of India

## ADMINISTRATION

Manpower position during the period 1.4.2015 to 31.3.2016.

### (a) Staff Strength

NIOT has a total strength of 168 staff members, the details of which are furnished here under:

Sl.No	Category	No. of Posts Sanctioned	No. of Posts Filled	No. of Posts Vacant
1.	Director	1	-	1
2.	Scientific	89	88	1
3.	Technical	54	54	NIL
4.	Administrative	18	18	NIL
5.	Multi-Tasking Staff	6	6	Nil
	<b>Total</b>	<b>168</b>	<b>166</b>	<b>2</b>

### (b) Appointments

Sl.No	Name	Post	Date of Appointment
1.	Shri K.Thirumurugan (Mech.)	Scientist 'C'	29.04.2015
2.	Smt G.V.Ahalya	Executive	27.07.2015
3.	Shri Biswajit Halder (Inst.)	Scientist 'B'	29.10.2015
4.	Shri Anand Kishor (Mech.)	Scientist 'B'	29.10.2015
5.	Ms Anulekha Majumdar (Mech.)	Scientist 'B'	29.10.2015

### (c) Promotions Under Modified Flexible Complementing Scheme

Sl.No	Name	Post	With effect from
1.	Dr.S.Ramesh (Geology)	Scientist 'F'	01.07.2015
2.	Shri R.Srinivasan (Inst.& Control)	Scientist 'E'	01.07.2015
3.	Dr.(Smt).K.Jossia Joseph (Oceanography)	Scientist 'D'	01.07.2015
4.	Shri G.Dhinesh (Mech.)	Scientist 'D'	01.07.2015
5.	Shri J.Rajkumar (Comp.Sci.)	Scientist 'D'	01.07.2015
6.	Shri K.Mullaivendhan (Civil)	Scientist 'D'	01.07.2015
7.	Shri A.Umapathy (EEE)	Scientist 'C'	01.07.2015



Sl.No	Name	Post	With effect from
8.	Smt.Sarojani Maurya (EEE)	Scientist 'C'	01.07.2015
9.	Shri K.Prabhakaran (Comp.ScL)	Scientist 'C'	01.07.2015
10.	Shri Tavva Abhishek (Civil)	Scientist 'C'	01.07.2015
11.	Shri Raju Abraham (Mech.)	Scientist 'F'	01.01.2016
12.	Dr.S.V.S.Phanikumar (Mech.)	Scientist 'F'	01.01.2016
13.	Shri R.Saravanan (Civil)	Scientist 'E'	01.01.2016
14.	Shri A.N.Subramanian (Elec.)	Scientist 'E'	01.01.2016
15.	Smt. K.Chithra (ECE)	Scientist 'E'	01.01.2016
16.	Smt.Nidhi Varshney (EEE)	Scientist 'D'	01.01.2016
17.	Dr. (Smt.) M.C.Sanjana (Oceanography)	Scientist 'D'	01.01.2016
18.	Shri Samson Packiaraj (Mech.)	Scientist 'D'	01.01.2016
19.	Shri S.Ramasundaram (LT.)	Scientist 'D'	01.01.2016
20.	Shri C.Janarthanan (Mech.)	Scientist 'D'	01.01.2016
21.	Shri Tamshuk Chowdhury (Mech.)	Scientist 'D'	01.01.2016
22.	Shri A.S.Kiran (Civil)	Scientist 'D'	01.01.2016
23.	Dr.L.Anburajan (Marine Biology)	Scientist 'C'	01.01.2016

#### (d) Promotion under Career Progression Path

Sl.No	Name	Post	With effect from
1.	Smt.G.Hemavathi	Senior Executive	01.07.2015
2.	Smt.T.Latha	Senior Executive	01.07.2015
3.	Smt.J.Vatchala Kuppuraman	Senior Executive	01.07.2015
4.	Shri B.Parmeswar	Technician Grade 'B'	01.01.2016
5.	Shri J.A.Rajan	Technician Grade 'B'	01.01.2016

#### (e) Resignations

Sl.No	Name	Post	Date of Resignation
1.	Shri Prasad Punna	Scientist 'C'	30.04.2015
2.	Shri R.Selva Kumar	Scientist 'B'	31.07.2015

#### (f) Retirements - Nil

## RIGHT TO INFORMATION

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

### Right to Information Annual Return 2015 – 2016

Ministry / Department / Organization : National Institute of Ocean Technology, Chennai  
Ministry of Earth Sciences  
Year : 2015 – 16 (April 2015 to March 2016)

Progress in 2015 - 2016						
	Opening Balance as on 01.04.2015	No. of applications received as transfer from other Pas u/s 6(3)	Received during the Year (including cases transferred to other Public Authority)	No. of cases transferred to other Public Authorities	Decisions where requests / appeals rejected	Decisions where requests / appeals accepted
Requests	0	14	18	2	1	27
First Appeals	0	0	0	0	0	0

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	1	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
240	126	-





<b>RTI Annual Return Information System (2015 - 2016)</b>	
<b>National Institute of Ocean Technology, Chennai</b> <b>Ministry of Earth Sciences</b> (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	Dr. G.A. Ramadass
* Nodal / Coordinating Officer designation	Scientist - G
* 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 3388
Fax No., (if any)	044 – 2246 0275
Website address of Department / Organization (Please do not write 'http://')	www.niot.res.in

<b>RTI Annual Return Information System (2015 – 2016)</b>	
<b>National Institute of Ocean Technology, Chennai</b> <b>Ministry of Earth Sciences</b> (Please note that fields prefixed with * are mandatory)	
* Name of CPIO	Dr. G. A. Ramadass
* Gender	Male
* Designation	Scientist – G
* Address	National Institute of Ocean Technology, Velachery – Tambaram Main Road, Pallikaranai, Chennai.
Pin code	600 100
Phone No.	6678 3388
Email	cpio@niot.res.in
* Appellate Authority Name	Dr. S.S.C. Shenoi, Director, NIOT, Chennai

## **INDEPENDENT AUDITOR'S REPORT**

To  
The Chairman & Members  
Governing Body of National Institute of Ocean Technology, Chennai

### **Report on the Standalone Financial Statements**

We have audited the attached Balance Sheet of National Institute of Ocean Technology (NIOT), NIOT Campus, Velachery-Tambaram Main Road, Pallikaranai, Chennai 600 100 as at 31st March 2016 and also the Income and Expenditure account and Receipts and Payments account for the year ended on that date and a summary of significant accounting policies and other explanatory information.

### **Management's Responsibility for the (Standalone) Financial Statements**

NIOT's Management is responsible for the preparation of these Standalone financial statements that give a true and fair view of the financial position, financial performance and cash flows of the Institute in accordance with the accounting principles generally accepted in India. This responsibility also includes maintenance of adequate accounting records for safeguarding the assets of the Institute and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments 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 statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

### **Auditor's Responsibility**

Our responsibility is to express an opinion on these (Standalone) financial statements based on our audit. We have conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and the disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to the organisation's preparation of the financial statements that give a true and fair view in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an



opinion on whether the organization has in place an adequate internal financial controls system over financial reporting and the operating effectiveness of such controls. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by the management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the (Standalone) financial statements.

### **Report on other Requirements**

On the basis of our verification, we report that:-

- i) We have obtained all the information and explanation, which to the best of our information and knowledge and belief are necessary for the purpose of the Audit.
- ii) 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 the examination of the books.
- iii) The Balance Sheet, Income & Expenditure account and Receipts and Payments Account dealt with by this report are in agreement with the books of account.
- iv) In our opinion, the Balance Sheet and Income & Expenditure account dealt with by this report is prepared in accordance with the applicable Accounting Standards issued by the Institute of Chartered Accountants of India except the non-compliance stated below.

### **Opinion**

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 the Institute as at 31 March 2016 and its Income and Expenditure Account and its Receipts and Payments Account for the year ended on that date subject to

***Non-accounting of Leave encashment and Gratuity on accrual basis in accordance with Accounting standard 15 issued by the Institute of Chartered Accountants of India. The impact of the same could not be quantified in the absence of actuarial valuation of retirement benefits.***

**For Gopalaiyer & Subramanian  
Chartered Accountants  
Firm Reg. No: 000960S**

**K.K.A.Ramanujan  
Partner  
M. No: 209498**

Date: August 17, 2016  
Place: Chennai 600 100



# NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

## BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016

(Amount in Rupees)

<b>LIABILITIES</b>	<b>Schedule</b>	<b>31.03.2016</b>	<b>31.03.2015</b>
CAPITAL FUND	1	3,495,329,306	6,130,023,779
RESERVES AND SURPLUS	2	312,502,701	258,347,462
earmarked / SPONSORED PROJECT FUNDS	3	262,433,558	552,474,406
CURRENT LIABILITIES AND PROVISIONS	4	1,459,629,347	1,057,537,392
<b>TOTAL</b>		<b>5,529,894,912</b>	<b>7,998,383,039</b>
<b>ASSETS</b>			
FIXED ASSETS	5	2,542,848,130	5,190,188,041
INVESTMENTSOCEAN TECHNOLOGY AND EARMARKED /	6	1,045,526,507	1,066,016,141
SPONSORED PROJECT FUNDS	7	1,060,177,174	987,101,107
INVESTMENTSOOTHERS	8	881,343,101	755,077,750
CURRENT ASSETS, LOANS, ADVANCES, ETC.		<b>5,529,894,912</b>	<b>7,998,383,039</b>
<b>TOTAL</b>			
Significant Accounting Policies	15		
Contingent Liabilities and Notes to Accounts	16		

**For National Institute of Ocean Technology, Chennai**  
**As per our Report of even date**  
**For Gopalaiyer and Subramanian**  
**Chartered Accountants**  
**FIRM REGN.NO.000960S**

**Sd/-**  
**DEPUTY MANAGER**  
**(F&A)**

**Sd/-**  
**DIRECTOR**

Date: August 17, 2016  
 Place: Chennai 600 100

**Sd/-**  
**K.K.A.RAMANUJAN**  
**PARTNER**  
**Memb No: 209498**





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

	<i>(Amount in Rupees)</i>		
	<b>31.03.16</b>	<b>31.03.15</b>	<b>31.03.15</b>
<b>SCHEDULE 1 - CAPITAL FUND</b>			
BALANCE AS AT THE BEGINNING OF THE YEAR			6,078,736,949
Add: Additions during the year	326,125,854	213,548,741	
Less: Excess of Expenditure over income	110,599,405	55,831,947	
Less: Provision for depreciation	2,801,873,608	106,429,964	
Less: Provision for loss/unserviceable assets	48,347,314	-	51,286,830
<i>(For details : Sub-schedule-A)</i>			
<b>BALANCE AT THE YEAR END</b>		<b>3,495,329,306</b>	<b>6,130,023,779</b>



## NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

**Sub-schedule: A attached to and forming part of Schedule-1 of the Balance Sheet as on 31<sup>st</sup> March 2016**  
**CAPITAL FUND**

S. No.	Name of the Fund	Balance as on 01.04.15	Additions during the year	Total (3+4)	Depreciation	Provision for loss/unserviceable assets	Balance as on 31.03.16 (5-6-7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<b>CAPITAL FUND</b> (Created out of MoES Grants)						
1	Land & Buildings Fund	366,055,961	-	366,055,961	17,130,744	-	348,925,217
2	A&N Centre Infrastructure Fund	211,379,838	5,000,000	216,379,838	1,035,223	-	215,344,615
3	General Equipment Fund	29,071,697	5,000,000	34,071,697	5,460,077	-	28,611,620
4	Ocean Technology Equipment Fund	1,331,192,395	221,400,000	1,552,592,395	73,423,677	34,745,005	1,444,423,713
5	Earmarked Projects Capital Fund	4,192,323,888	94,725,854	4,287,049,742	2,704,823,887	13,602,309	1,568,623,546
	<b>GRAND TOTAL</b>	<b>6,130,023,779</b>	<b>326,125,854</b>	<b>6,456,149,633</b>	<b>2,801,873,608</b>	<b>48,347,314</b>	<b>3,605,928,711</b>

**Sub-Schedule : A**





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

(Amount in Rupees)

<b><u>SCHEDULE 2 - RESERVES AND SURPLUS</u></b>		<b>31.03.16</b>		<b>31.03.15</b>	
<b>(i)</b>	<b>Reserves created out of Technical / Consultancy Projects</b>				
	<b>General Reserve Fund</b>				
	As per last Account	209,545,102		190,516,906	
	Additions during the year	60,073,907		20,144,662	
	Deductions during the year	343,157	269,275,852	1,116,466	209,545,102
	Sub - Total		269,275,852		209,545,102
<b>(ii)</b>	<b>Staff Welfare Fund</b>				
	As per last Account	238,095		238,095	
	Additions during the year	2,079,327		-	
	Deductions during the year	5,723	2,311,699	-	238,095
	Sub - Total		2,311,699		238,095
<b>(iii)</b>	<b>Scientific &amp; Technical Consultancy Project Equipment Fund</b>				
	As per last Account	48,564,265		57,859,021	
	Additions during the year	16,800		159,794	
	Less: Depreciation on the assets created	135,145		135,997	
	Less: Depreciation on the assets of Kalpasar Consultancy Projects	7,530,770	40,915,150	9,318,553	48,564,265
	Sub - Total		40,915,150		48,564,265
	<b>GRAND TOTAL (i+ii+iii)</b>		<b>312,502,701</b>		<b>258,347,462</b>

Schedule -2



**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

**SCHEDULE-3 EARMARKED / SPONSORED PROJECT FUNDS**

Details / Grants pertaining to (1)	Balance as on 1.4.2015 (2)	Add: Receipts		Less: Expenditure		Balance as on 31.03.16 (7)
		Grants Received (3)	Other Receipts and Interest (4)	Expenditure Revenue (5)	Project Equipment/WIP (6)	
<b>A. MoES GRANTS</b>						
<b>a. OCEAN RESEARCH VESSELS</b>						
Operation and Maintenance of Coastal Research Vessels 'Sagar Purvi & Sagar Paschimi'	96,704	-	-	192,653,891	4,558,621	-197,115,808
Operation and Maintenance of 'BTV Sagar Manjusha'	99,795,145	136,100,000	-	190,906,307	-	44,988,838
Operation & Maintenance of Research Vessel 'Sagar Nidhi'	181,680,830	388,500,000	673,206	526,347,699	-	44,506,337
Acquisition of two Coastal Research Vessels (CRVs)	5,581,027	210,000,000	3,630,809	1,024,796	-	218,187,040
<b>b. OCEAN OBSERVATIONS</b>						
Ocean Observation Network	3,454,459	220,000,000	3,238,055	185,858,491	25,305,294	15,528,729
<b>c. OCEAN SURVEY &amp; MINERAL RESOURCES</b>						
Scientific studies and technology development for exploration and extraction of Gas Hydrates	120,781,348	-	6,031,570	26,266,359	63,533,504	37,013,055
Seabed Survey using Multibeam Sonar System - EEZ Programme	71,741,648	-	2,207,552	2,251,076	446,435	71,251,689
<b>d. RESEARCH, EDUCATION, TRAINING &amp; OUTREACH</b>						
User Oriented M.Tech Course on 'Ocean Technology Management'	498,000	-	-	-	-	498,000
<b>e. OTHER PROGRAMMES</b>						
Seawater Quality Monitoring	-1,859,558	4,800,000	-	1,803,875	-	1,136,567
Ocean Observation System - Indian ARGO	2,759,836	-	193,432	-	-	2,953,268
Information Technology and E-Governance activities	7,164,218	-	549,358	7,373	-	7,706,203
Development and deployment of low cost data met buoys	5,982,747	-	454,150	570,110	882,000	4,984,787
<b>SUB-TOTAL - A</b>	<b>497,676,404</b>	<b>959,400,000</b>	<b>16,978,132</b>	<b>1,127,689,977</b>	<b>94,725,854</b>	<b>251,638,705</b>
<b>B. OTHER GOVERNMENT GRANTS</b>						
NCAOR - Southern Ocean Expedition Cruise	54,787,592	-	-	45,897,279	-	8,890,313
CSIR Fellowship	10,410	434,018	-	439,888	-	4,540
INSPIRE Faculty Awardees selected under INSPIRE Faculty Award Programme	-	1,900,000	-	-	-	1,900,000
<b>SUB-TOTAL - B</b>	<b>54,798,002</b>	<b>2,334,018</b>	<b>-</b>	<b>46,337,167</b>	<b>-</b>	<b>10,794,853</b>
<b>TOTAL-A+B</b>	<b>552,474,406</b>	<b>961,734,018</b>	<b>16,978,132</b>	<b>1,174,027,144</b>	<b>94,725,854</b>	<b>262,433,558</b>





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

<b>SCHEDULE 4 - CURRENT LIABILITIES &amp; PROVISIONS</b>		<b>(Amount in Rupees)</b>	
		<b>31.03.16</b>	<b>31.03.15</b>
<b>A. STATUTORY LIABILITIES</b>			
Tax deducted / Collection at source payable		1,790,424	1,637,077
Works Contract Tax / Vat Payable		151,937	8,805
CPF Contribution		2,065,776	3,011,375
NPS Contribution		504,373	482,002
			5,139,259
<b>B. OTHER CURRENT LIABILITIES</b>			
Pay & allowances for the month of March 2016		24,571,939	22,752,956
Outstanding Liabilities		482,177,450	98,230,964
Earnest Money & Retention money		52,768,096	63,595,932
Interest & Other Incomes Earned during the Year 2015-16 under the programme "Ocean Technology" refundable to Ministry of Earth Sciences, Government of India transferred to Schedule 4 - Current Liabilities & Provisions		76,862,433	83,967,444
Project Advances (Vide Sub-Schedule:B)			268,547,296
		818,736,919	783,850,837
<b>TOTAL (A+B)</b>		<b>1,459,629,347</b>	<b>1,057,537,392</b>



## NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

### SUB-SCHEDULE:B FORMING PART OF SCHEDULE-4 OF THE BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016

Details / Grants pertaining to	Balance as on 1.4.2015	Add: Receipts		Less: Expenditure		Balance as on 31.03.16
		Received	Other Receipts & Interest	Revenue	Capital	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>PROJECT ADVANCES</b>						
Scientific and Technical Consultancy Services	86,129,442	54,240,013	1,791,430	76,741,617	16,800	65,402,468
<i>On Deposit</i> : Procurement of self propelled barge	3,872,126	-	361,179	-	-	4,233,305
<i>On Deposit</i> : Installation of 1 lakh litres per day capacity Seawater Low Temperature Thermal Desalination Plants at Agatti,Andrott, Minicoy, Amini, Kiltan & Chetlah Islands	693,849,269	-	56,360,985	1,109,108	-	749,101,146
<b>TOTAL - B</b>	<b>783,850,837</b>	<b>54,240,013</b>	<b>58,513,594</b>	<b>77,850,725</b>	<b>16,800</b>	<b>818,736,919</b>

Sub-Schedule:B





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

**SCHEDULE 5 - FIXED ASSET'S**

(Amount in Rupees)

S.No.	DESCRIPTION	GROSS BLOCK			DEPRECIATION				Provision for loss / unserviceable assets	NET BLOCK	
		Cost/Valuation as on 01.04.15	Additions during the year	Deletions	Cost/Valuation as on 31.03.16	Upto 01.04.15	Additions during the year	Deletion during the year	Total upto 31.03.16	As on 31.03.16	As on 31.03.15
<b>A.</b>	<b>FIXED ASSETS created out of MoES Grants</b>										
1	<b>Lands-Freehold</b>										
	NIOT Campus, Pallikaranai	35,367,827	-	-	35,367,827	-	-	-	-	35,367,827	35,367,827
	Freehold Land -Dollygunj	3,729,070	-	-	3,729,070	-	-	-	-	3,729,070	3,729,070
	A&N Islands										
	Seafont Facility - Acquisition of Land at Nellore, Andhra Pradesh	108,150,055	-	-	108,150,055	-	-	-	-	108,150,055	108,150,055
2	<b>Buildings</b>										
	Buildings & Infrastructure at NIOT Campus	393,475,759	115,645,906	1,446,014	507,675,651	279,836,119	17,130,744	1,308,288	295,658,575	212,017,076	113,639,640
	Farm Buildings at ANC-NIOT	27,893,543	-	-	27,893,543	17,610,375	1,035,223	-	18,645,598	9,247,945	10,283,168
3	<b>Equipment</b>										
	General Equipment	100,964,751	3,190,346	49,880	104,105,217	78,261,052	5,460,077	33,185	83,687,944	20,417,273	22,703,699
	Equipment of Ocean Technology Programmes	1,355,691,600	79,483,325	91,900	1,435,083,025	908,971,069	73,423,677	87,783	982,306,963	418,031,057	446,720,531
	Equipment of Earmarked / Sponsored Projects	4,131,431,414	84,197,857	294,810	4,215,334,461	-	2,704,823,887	183,623	2,704,640,264	1,497,091,888	4,131,431,414
	<b>TOTAL UNDER (A)</b>	<b>6,156,704,019</b>	<b>282,517,434</b>	<b>1,882,604</b>	<b>6,441,104,057</b>	<b>1,284,678,615</b>	<b>2,801,873,608</b>	<b>1,612,879</b>	<b>4,084,939,344</b>	<b>2,304,052,191</b>	<b>4,872,025,404</b>
<b>B</b>	<b>Capital work in progress</b>	<b>269,598,372</b>	<b>20,096,237</b>	<b>91,813,819</b>	<b>197,880,790</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>197,880,790</b>	<b>269,598,372</b>
<b>C</b>	<b>Fixed Assets created out of Scientific &amp; Technical Consultancy Projects</b>										
1	Scientific & Technical Equipment	12,957,246	16,800	-	12,974,046	12,074,961	135,145	-	12,210,106	763,940	882,285
2	Assets created out of Kalpasar Project	114,866,958	-	-	114,866,958	67,184,978	7,530,770	-	74,715,748	40,151,210	47,681,980
	<b>GRAND TOTAL (A+B+C)</b>	<b>6,554,126,595</b>	<b>302,630,471</b>	<b>93,696,423</b>	<b>6,766,825,851</b>	<b>1,363,938,554</b>	<b>2,809,539,523</b>	<b>1,612,879</b>	<b>4,171,865,198</b>	<b>2,542,848,131</b>	<b>5,190,188,041</b>

Schedule 5



**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

<b><u>SCHEDULE 6 - INVESTMENTS - OCEAN TECHNOLOGY &amp; EARMARKED / SPONSORED PROJECT FUNDS</u></b>		<b>(Amount in Rupees)</b>	
		<b>31.03.16</b>	<b>31.03.15</b>
a. Ocean Technology Programmes		738,248,149	801,669,796
b. Earmarked / Sponsored Project Funds		307,278,358	264,346,345
<b>TOTAL</b>		<b>1,045,526,507</b>	<b>1,066,016,141</b>

<b><u>SCHEDULE 7 - INVESTMENTS - OTHERS</u></b>		<b>(Amount in Rupees)</b>	
		<b>31.03.16</b>	<b>31.03.15</b>
Funds received for rendering Scientific and Technical Consultancy Services		65,362,454	81,031,229
b. General Reserve Fund		265,858,518	205,720,816
c. Staff Welfare Fund		2,033,240	-
d. Deposits from other Agencies		726,922,962	700,349,062
<b>TOTAL</b>		<b>1,060,177,174</b>	<b>987,101,107</b>

(All the investments are with Nationalised Banks in Short Term Deposits)

Schedule 6 & 7





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

<b>SCHEDULE 8 - CURRENTS ASSETS, LOANS &amp; ADVANCES</b>		<b>(Amount in Rupees)</b>	
		<b>31.3.16</b>	<b>31.3.15</b>
<b>A. CURRENT ASSETS</b>			
<i>Balance with Banks in Savings Accounts</i>		276,635,358	113,269,356
<b>B. LOANS AND ADVANCES</b>			
<b>i Capital Advances</b>			
Land Acquisition for Sea Front Facility at Nellore, Andhra Pradesh		72,779,945	65,849,945
Development of Infrastructure facilities at ANCOST, NIOT, Port Blair		14,431,699	31,710,196
<b>ii Staff Advances</b>			
<i>Non-Interest bearing Advances to employees</i>		5,271,802	378,210
<i>Interest bearing Advances to employees</i>		192,921	98,370
<b>iii Advances and other amounts recoverable in cash or in kind for value to be received</b>			
Imprest Advance made to M/s.Shipping Corporation of India Limited		344,803,621	386,500,000
Recoverable from Revenue Authorities		41,589,092	45,114,367
Prepaid Expenses		10,697,525	10,881,659
Reimbursable expenses		1,330,897	478,417
Project Advances		37,875,944	45,167,579
Advance Payment to Suppliers		4,006,694	4,376,720
Other Receivables		6,726,277	2,969,749
<b>iv Interest accrued but not due</b>			
Personal Computer Advance/Motor car advance to employees		16,907	3,889
Investments from Ocean Technology Programmes		17,992,778	15,432,061
Investments from Earmarked / Sponsored Project Funds		8,134,750	4,366,608
Investments from Scientific & Technical Consultancy Projects		2,002,780	3,082,724
Investments from General Reserve Fund		6,244,546	6,347,532
Investments from Staff Welfare fund		46,087	-
Investments made out of Deposits from other Agencies		30,563,480	19,050,368
<b>TOTAL</b>		<b>881,343,101</b>	<b>755,077,750</b>

Schedule-8



**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31<sup>ST</sup> MARCH 2016**

		<i>(Amount in Rupees)</i>	
<b>INCOME</b>	<b>Schedule</b>	<b>2015-16</b>	<b>2014-15</b>
Scientific and Technical Consultancy Services		97,716,228	-
Grants-in-aid - Ocean Technology Programmes	9	451,567,444	442,965,507
Interest Earned	10	62,994,310	81,464,352
Other Income	11	13,868,123	2,503,092
<b>TOTAL (A)</b>		<b>626,146,105</b>	<b>526,932,951</b>
<b>EXPENDITURE</b>			
Expenditure on Scientific and Technical Consultancy Services		54,765,240	-
Establishment Expenses	12	166,392,706	152,158,273
Administrative Expenses	13	43,036,207	43,809,547
Expenditure on Ocean Technology Programmes	14	352,737,936	302,769,560
<b>TOTAL (B)</b>		<b>616,932,089</b>	<b>498,737,380</b>
Interest & Other Incomes Earned during the Year 2015-16 under the programme "Ocean Technology" refundable to Ministry of Earth Sciences, Government of India transferred to Schedule 4 - Current Liabilities & Provisions	4	76,862,433 110,599,405	83,967,444 55,771,872
Balance being excess of Expenditure over Income transferred to Schedule 1- Capital Fund		40,917,748	-
Appropriations on Scientific and Technical Consultancy Services		2,033,240	-
General Reserve Fund		<b>626,146,105</b>	<b>526,932,951</b>
Staff Welfare Fund			
Significant Accounting Policies	15		
Contingent Liabilities and Notes to Accounts	16		

**As per our Report of even date**  
**For Gopalaier and Subramanian**  
**Chartered Accountants**  
**FIRM REGN.NO.000960S**

**For National Institute of Ocean Technology, Chennai**

**Date: August 17, 2016**  
**Place: Chennai 600 100**

**DEPUTY MANAGER**  
**(F&A)**

**DIRECTOR**

**K.K.A.RAMANUJAN**  
**PARTNER**  
**Memb No: 209498**





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

<b><u>SCHEDULE 9 - GRANTS</u></b>	<b>(Amount in Rupees)</b>	
	<b>2015-16</b>	<b>2014-15</b>
Grants-in-aid received for Ocean Technology Programmes		
Add: Amount of Interest & Other Incomes earned during the year 2014-15	599,000,000	508,999,414
	83,967,444	88,716,093
Less: Amount allocated for Capital Expenditure and transferred to Capital Fund		
(1) Equipment of Ocean Technology Programmes	221,400,000	83,949,481
(2) Building & Infrastructure Activities at NIOT, Chennai & ANCOST, Port Blair, A&N islands	5,000,000	65,800,519
(3) General Equipment	5,000,000	5,000,000
		154,750,000
<b>TOTAL</b>	<b>451,567,444</b>	<b>442,965,507</b>

Schedule-9



**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

	<i>(Amount in Rupees)</i>	
<b><u>SCHEDULE 10 - INTEREST EARNED</u></b>	<b>2015-16</b>	<b>2014-15</b>
On Savings Account	3,972,870	3,204,405
On Term Deposits	59,021,440	78,259,947
<b>TOTAL</b>	<b>62,994,310</b>	<b>81,464,352</b>

	<i>(Amount in Rupees)</i>	
<b><u>SCHEDULE 11 - OTHER INCOME</u></b>	<b>2015-16</b>	<b>2014-15</b>
Rent Received	615,775	747,588
Sundry Receipts	13,252,348	1,755,504
<b>TOTAL</b>	<b>13,868,123</b>	<b>2,503,092</b>

*Schedule-10 & 11*





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

(Amount in Rupees)			
<b>SCHEDULE 12 - ESTABLISHMENT EXPENSES</b>		<b>2015-16</b>	<b>2014-15</b>
Pay & Allowances		152,475,314	138,405,566
CPF Contribution		2,065,776	3,011,375
NPS Contribution		5,853,529	4,726,456
Terminal Benefits - Gratuity		-	780,012
Terminal Benefits - Leave Encashment		127,999	299,400
Medical Reimbursements		1,466,590	1,518,243
Children's Education Allowance		2,395,356	1,223,704
Overtime Allowances		-	1,997
Leave Travel Concession		2,008,142	2,191,520
<b>TOTAL</b>		<b>166,392,706</b>	<b>152,158,273</b>

<b>SCHEDULE 13 - ADMINISTRATIVE EXPENSES</b>		<b>2015-16</b>	<b>2014-15</b>
Computer Maintenance/LAN/Software / Maintenance of Plant & Machinery		8,014,817	8,227,153
Electricity & Water Charges		9,151,201	8,031,395
Campus Maintenance Expenses		9,994,605	11,730,822
Vehicles Running and Maintenance		1,700,711	1,433,792
Conveyance Expenses		1,372,771	2,091,434
Travel Expenses		3,415,993	2,652,754
Subscriptions to Journals & Bulletins		610,290	1,189,186
Expenses on Seminars & Workshops		119,407	341,584
Communication Expenses		901,056	692,309
Postage & Fax		285,465	303,834
Printing and Stationery		737,097	594,020
Advertisement & Publicity		331,892	715,301
Rent, Rates and Taxes		1,289,435	1,198,225
Hospitality Expenses		1,289,239	1,036,418
Professional charges		1,222,884	1,491,496
Loss on sale of Fixed Assets		61,538	-
Auditor's Remuneration		69,000	68,400
Other Administrative Expenses		2,468,806	2,011,424
<b>TOTAL</b>		<b>43,036,207</b>	<b>43,809,547</b>

Schedule-12 & 13

# **NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**

## **SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31<sup>ST</sup> MARCH 2016**

**(Amount in Rupees)**

<b>SCHEDULE 14-EXPENDITURE ON OCEAN TECHNOLOGY PROGRAMMES</b>	<b>2015-16</b>	<b>2014-15</b>
<b>Ocean Energy and fresh water</b>	34,232,400	30,365,862
Inter-Institutional R&D and In-House development & development of Upgraded Version of Soil Tester(Part of Deep Sea Mining Programme)	18,077,639	3,050,733
Marine Sensors & Electronics	11,735,146	11,668,285
Technical Criteria Atlas	24,490,981	23,767,752
Development of Ocean Acoustics	25,992,259	25,952,734
Ocean Electronics	18,070,704	18,770,221
Ocean Sciences & Technology for Islands	62,038,981	46,240,704
Development of Technologies for Offshore Structural component	53,863,620	28,846,540
Sea Front Facility	2,464,097	2,880,374
Shoreline Management	26,306,375	64,311,625
Pre-project activities of large scale desalination plant and studies on complex offshore components and thermal components	71,0068,4	12,650,060
Integrated Deep Sea Mining System for Mining of Polymetallic Nodules upto 6000m Depth	60,442,968	23,438,561
Establishment of Low Temperature Thermal Desalination (LTTD) Plant at Tuticorin Thermal Power Station	66,279	87,557
Development of Manned and Unmanned Submersible	6,239,752	10,738,552
Pre-investment activity of the two proposed National Oceanarium @ Puduchery and Diu	245,729	-
<b>TOTAL</b>	<b>352,737,936</b>	<b>302,769,560</b>





**NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**  
**RECEIPTS AND PAYMENTS FOR THE YEAR ENDED 31<sup>ST</sup> MARCH 2016**

RECEIPTS	2015-16	2014-15	PAYMENTS	2015-16	2014-15
<b>I. Opening Bank Balances</b>	113,269,357	106,828,117	<b>I. Expenses</b>	146,781,808	132,753,891
			a) Establishment Expenses	38,550,887	40,977,611
			b) Administrative Expenses		
<b>II. Grants Received</b>			<b>II. Payments made against funds for various projects</b>		
a) Ocean Technology Programmes	599,000,000	508,999,414	a) Ocean Technology Programmes	292,104,115	274,678,723
b) Earmarked Project Grants from MoES	959,400,000	763,575,000	b) Earmarked Projects from MoES	842,705,888	286,623,549
sources	2,334,018	27,464,265	c) Sponsored Projects from other sources	3,358,143	9,759,219
			d) Deposit from other agencies	1,091,369	-
<b>III. Scientific &amp; Technical Consultancy Services</b>	54,240,013	50,484,807	<b>III. Scientific &amp; Technical Consultancy Services</b>	75,277,620	427,182
<b>IV. Short term deposits matured</b>	1,213,566,419	1,515,100,956	<b>IV. Short term deposits made</b>	1,140,671,211	1,397,949,885
<b>V. Interest Received</b>			<b>V. Purchase of Fixed Assets</b>	72,195,110	141,756,687
a. Ocean Technology	13,023,491	20,023,368			
b. Earmarked / Sponsored Project funds	6,934,954	6,714,323			
<b>VI. Other Incomes</b>	8,336,738	1,024,275	<b>VI. Other Payments</b>	160,618,471	624,281,604
<b>VII. Any Other Receipts</b>	79,884,990	22,263,183	<b>VII. Closing Bank Balances</b>	276,635,358	113,269,357
<b>TOTAL</b>	<b>3,049,989,980</b>	<b>3,022,477,708</b>	<b>TOTAL</b>	<b>3,049,989,980</b>	<b>3,022,477,708</b>

(Amount in Rupees)

For National Institute of Ocean Technology, Chennai

As per our Report of even date  
For Gopalaiyer & Subramanian  
Chartered Accountants  
F.R.NO.000960S

Date: August 17, 2016  
Place: Chennai 600 100

DEPUTY MANAGER (F&A)      DIRECTOR

KKA. RAMANUJAN  
Partner  
M.No.209498

## **NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI**

### **SCHEDULE-15 : SIGNIFICANT ACCOUNTING POLICIES**

#### **1. GENERAL INFORMATION:**

- (i) The Government of India under the Gazette Notification Resolution No.DOD/16-TE/16/92 dated 1<sup>st</sup> September 1993 established the National Institute of Ocean Technology. 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 5<sup>th</sup> 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.11/358/98-TU-V dated 15<sup>th</sup> June, 2010 recognized National Institute of Ocean Technology, Chennai as a Scientific and Industrial Research Organization for a period up to 31<sup>st</sup> March 2013. The renewal of recognition as a Scientific and Industrial Research Organisation by Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India vide their letter No.11/358/98-TU-V dated 9<sup>th</sup> May 2013 for a period from 1<sup>st</sup> April 2013 to 31<sup>st</sup> March 2016 and vide letter No. 11/358/98-TU-V dated 23<sup>rd</sup> March 2016 accorded renewal of recognition from 1<sup>st</sup> April 2016 to 31<sup>st</sup> March 2019.
- (v) 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 23<sup>rd</sup> March 2016 has accorded exemption for availing Customs Duty in terms of Government Notifications No.51/96- Customs dated 23<sup>rd</sup> July 1996 and



No.24/2007-Customs dated 1<sup>st</sup> March 2007 and Central Excise duty exemption in terms of Government Notifications No.10/97-Central Excise dated 1<sup>st</sup> March 1997 and No.16/2007-Central Excise dated 1<sup>st</sup> March 2007 and the registration is valid upto 31<sup>st</sup> March 2019.

- (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.
- (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 29<sup>th</sup> October 2012 from Assessment year 2011-12.
- (viii) The enterprise is a level II entity as defined in preface to Accounting Standards issued by the Institute of Chartered Accountants of India. Accordingly, the enterprise 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 practices (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 accrual basis when there is reasonable assurance that the Institute will comply with the conditions attached to them and the grants will be received.
- (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) All other items of income/ expenditure are accounted on accrual basis in accordance with accounting standard-9 issued by the Institute of Chartered Accountants of India.

#### **4. FIXED ASSETS:**

- (i) Fixed Assets are carried at cost less depreciation.
- (ii) The Cost of an asset comprises 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 and manner specified in Income Tax Act, 1961.
- (ii) Depreciation relating to Ocean Technology programmes (funded by Government grants) and Equipment of Earmarked Funds / sponsored projects are charged to the assets and deducted from the Capital Funds.
- (iii) Depreciation on assets created out of NIOT's internal generation are charged to the assets and deducted from Scientific and Technical Project Equipment Fund created out of Technical/Consultancy Projects.

#### **6. VALUATION OF INVENTORIES:**

Purchases of raw materials, consumables and other inputs are restricted to minimum requirement of Research Programmes taken up and or on hand and thus stores is not maintained. These items are charged at cost to the respective projects on receipt and inspection.

#### **7. RESEARCH AND DEVELOPMENT EXPENDITURE:**

- (i) Research and Development expenditure on Ocean Technology is charged to Income & Expenditure Account in the year in which the expenditure is incurred.
- (ii) Research and Development expenditure on Scientific and Technical Consultancy Services are accumulated separately under 'Project Advances' which are carried net of such expenditure till completion of the project. The expenditure is charged to Income & Expenditure Account in the year of completion of the project.

#### **8. EARMARKED FUNDS:**

The Institute is receiving funds each year for certain specified project / schemes for the purpose of acquiring assets and meeting revenue expenses. The receipts and utilization of these specified funds for the projects / schemes are shown in Schedule-3.

#### **9. RATE OF EXCHANGE:**

Transactions in foreign currencies are recorded at the exchange rate prevailing on the date of transaction. Foreign currency monetary assets and liabilities are translated at year end exchange rates and resultant difference if any is recognised as exchange loss or gain as the case may be.





## **10. UNIFORM FORMAT OF ACCOUNTS FOR CENTRAL AUTONOMOUS BODIES:**

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

## **11. GRANTS-IN-AID (PLAN):**

All the Grants-in-aid received by NIOT from Ministry of Earth Sciences have been classified by the said Ministry as 'Grants-in-aid (Plan)'. Hence, the bifurcation of plan / non-plan items in the Income & Expenditure Account does not arise.

## **12. LONG TERM EMPLOYEE BENEFITS**

### **a) Defined Contribution Plan:**

The enterprise 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) New Pension Scheme (NPS) for its staff who have joined after 1<sup>st</sup> January 2004 and is administered by the PFRDA.

The above mentioned schemes are classified as defined contribution plan as the enterprise has no further obligation beyond making the contributions. The enterprise's contributions to the defined contribution plan are charged to Income & Expenditure Account on accrual.

### **b) Other Terminal Benefits:**

Gratuity, Leave encashment are recognised in Income and Expenditure Account in the year in which they are paid.

**For NATIONAL INSTITUTE OF  
OCEAN TECHNOLOGY**

**DEPUTY MANAGER (F&A)      DIRECTOR**

***Date : August 17, 2016***  
***Place: Chennai 600 100***

**As per our Report of even date  
For Gopalaiyer & Subramanian  
Chartered Accountants  
Firm Reg. No: 000960S**

**K.K.A. RAMANUJAN**  
**Partner**  
**M. No: 209498**

## NATIONAL INSTITUTE OF OCEAN TECHNOLOGY, CHENNAI

### SCHEDULE- 16 : NOTES ON ACCOUNTS

#### **1. Contingent Liabilities**

- (a) The Deputy Commissioner of Income Tax (Exemptions), Chennai had issued an order under Section-147 of Income Tax Act 1961 demanding a sum of Rs.1,35,35,14,730/- for the financial year 2006-07 on the grounds of improper claim under Section-11 of Income Tax Act, 1961. Aggrieved by the above order, NIOT had appealed with the Commissioner of Income Tax (Appeals) on 5<sup>th</sup> May 2015. Based on the merits of the case, NIOT had got 100% stay against the above demand from the Commissioner of Income Tax (Exemptions), Chennai on 23.7.15 till disposal of appeals by the Commissioner of Income (Appeals), Chennai. The case is currently under progress before the Commissioner of Income Tax (Appeals) Chennai.
- (b) A case filed by one of the Contract employee of NIOT against NIOT in Hon'ble Madras High Court for payment of terminal benefits for the contract services rendered. On the direction of the Hon'ble Madras High Court to settle the terminal benefits by NIOT, a clarification petition was filed by NIOT to obtain a clear direction on the applicability of Gratuity, PF and emoluments. Liability towards payment of terminal benefits would works out to Rs.1,27,007/- approximately.

#### **2. Pending Capital commitments**

Autonomous Coring System was procured from M/s. Williamson & Associates, USA at a cost of US\$ 57,40,950/-. Out of the above, as per terms & conditions, NIOT had paid Rs.22,69,33,295/- (US\$ 47,36,283.75 - 82.5% of the contract value) and capitalised the payments made as per the Accounting Standards-10 issued by Institute of Chartered Accountants of India. Pending capital commitment on account of the above contract is Rs.6,70,81,566/- (US\$ 10,04,666.25 - 17.5% of the contract value).

#### **3. Defined Benefit Pension Scheme**

Governing Council of NIOT during its 43<sup>rd</sup> meeting approved the implementation of Defined Benefit Pension Scheme through LIC for NIOT employees. During 2011-12, an initial premium of Rs.13,98,570/- was paid out of General Reserve Fund of the Institute. Pursuant to Finance Committee/Governing Council resolution dated 10/11<sup>th</sup> February 2016 to call back the premium from LIC of India, NIOT had initiated necessary action to get back the amount paid.

#### **4. Retirement Benefits to employees**

The regular employees of Central Autonomous Bodies are eligible for Death-cum Retirement Gratuity and Leave Encashment. As per Accounting Standards-5, the approximate accrued liability in respect of Retirement Benefits is to be provided in the Books of Accounts. The accrued liability in respect of NIOT regular employees as on 31st March 2016 are as follows:



a. Liability in respect of	Gratuity	:	Rs. 3,47,41,461/-
b. Liability in respect of	Leave Encashment	:	Rs. 8,06,31,506/-
			-----
TOTAL		:	Rs.11,53,72,967/-
			=====

## 5. Insurance claim

- (a) During the sea trials of Deep Sea Mining Test platform, aramid rope and cable used for launching and operation got twisted during the recovery operation. A huge swell occurred at this stage and both the aramid rope and cable were snapped from the system causing loss of some of the sub-systems in the test platform. The incident was immediately reported on 18<sup>th</sup> December 2012 to the Insurance Company, M/s. United India Insurance Company with whom a comprehensive policy was taken for the sea trials. The approximate cost of the items lost is reported to be Rs.97.80 lakhs (approx.) as per the Book value. The loss is being assessed by the Surveyor of the Insurance Company and NIOT is pursuing the claim. Pending settlement of the above claim, NIOT had provided for loss of assets amounting to Rs.1,15,54,265/-.
- (b) The Coastal Research Vessel 'Sagar Paschimi' acquired by the Ministry of Earth Sciences (MoES) for studying coastal pollution, coastal surveys and near shore multidisciplinary work was partially sunk at Visakhapatnam Fishing Harbour on 12<sup>th</sup> October 2014 due to the impact of HUD HUD Cyclone. In this regard, a claim was lodged with the New India Assurance Co. Ltd under the Hull & Machinery Policy. With the approval of the MoES, NIOT declared abandonment of the vessel and the New India Assurance Co. Ltd. treated the Vessel as a Constructive Total Loss and settled the full policy value of Rs.1.50 crores during June 2015. A separate claim for the scientific equipments onboard Sagar Paschimi has been lodged with M/s. United India Insurance Company Limited and is under active consideration.
- (c) Due to unprecedented floods that occurred in Chennai during November-December 2015, some of the assets of NIOT were partially / fully damaged. NIOT had made claim for totally damaged asset and refurbishing the partially damaged assets which are covered under insurance, with M/s. United India Insurance Company Limited, Chennai for a sum of Rs.15.96 crores. Pending settlement of the above claim, NIOT had made provision for fully damaged assets amounting to Rs.3,67,93,049/-

## 6. Ocean Technology

During the 12<sup>th</sup> Plan Period, Ministry of Earth Sciences has classified the programmes viz., Ocean Energy and Fresh water, Establishment of Low Temperature Thermal Desalination (LTTD) Plant at Tuticorin Thermal Power Station, Pre-project activities of

large scale desalination plant and studies on complex offshore components and thermal components, Inter-Institutional R&D and In-House development & development of Upgraded Version of Soil Tester (Part of Deep Sea Mining Programme), Integrated Deep Sea Mining System for Mining of Polymetallic Nodules upto 6000m Depth, Manned and Unmanned Underwater Vehicles, Marine Sensors & Electronics, Ocean Electronics, Ocean Acoustic, Technical Criteria Atlas, Shoreline Management, Development of Technologies for Offshore Structural component, Ocean Sciences & Technology for Islands, Manpower, Operational Expenses & Maintenance of NIOT, Sea Front Facility and Pre-investment activity of the two proposed National Oceanarium at Puduchery & Diu as OCEAN TECHNOLOGY and the Administrative Orders for these programmes has been issued by the Ministry of Earth Sciences, Government of India accordingly. During the financial year 2015-16, the Society received an amount of Rs.59,90,00,000/- as Grants-in-aid for the Ocean Technology Programmes from the Ministry of Earth Sciences, Government of India.

## **7. Earmarked Funds**

The Society during the financial year 2015-16 received an amount of Rs.96,17,34,018/- as Grants-in-aid towards Earmarked Funds from the Ministry of Earth Sciences and other Government Institutions in the form of recurring and non-recurring grants as specified under Schedule-3.

## **8. Depreciation on Assets acquired out of earmarked / sponsored funds:**

NIOT had stated charging depreciation on assets acquired out of earmarked/ sponsored projects. During the year a sum of Rs.270,46,40,264/- was provided in the books of accounts including accumulated depreciation upto Financial year 2014-15 amounting to Rs.246,81,39,216/-.

## **9. Investments**

The amount shown under the head 'Investments-Ocean Technology and Earmarked/Sponsored Project Funds' in the Balance Sheet includes the investments for Earmarked/Sponsored Project Funds and Current Liabilities.

- 10.** An amount of Rs.8,39,67,444/- being Interest and Other Income earned during the year 2014-15, shown under Current Liabilities is being accounted as Grants Received as this has been adjusted while releasing Grants by Ministry of Earth Sciences, Government of India during the year 2015-16.

## **11. 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 the Society 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 31<sup>st</sup> March of each financial year and 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 and an undertaking with a declaration that without the written consent of the Society, 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.

12. Figures shown in the accounts are rounded off to the nearest rupee.
13. Previous year figures have been regrouped / merged wherever necessary.
14. Schedules 1 to 16 are annexed to and form an integral part of the Balance Sheet as at 31<sup>st</sup> March 2016, Income and Expenditure Account and Receipts and Payments account for the year ended on that date.

Signatures to Schedule 1 to 16  
**For NATIONAL INSTITUTE OF  
OCEAN TECHNOLOGY**

**DEPUTY MANAGER (F&A)**

**DIRECTOR**

**As per our Report of even date  
For Gopalaiyer & Subramanian  
Chartered Accountants  
Firm Reg. No: 000960S**

**K.K.A. RAMANUJAN  
Partner  
M. No: 209498**

***Date: August 17, 2016  
Place: Chennai 600 100***