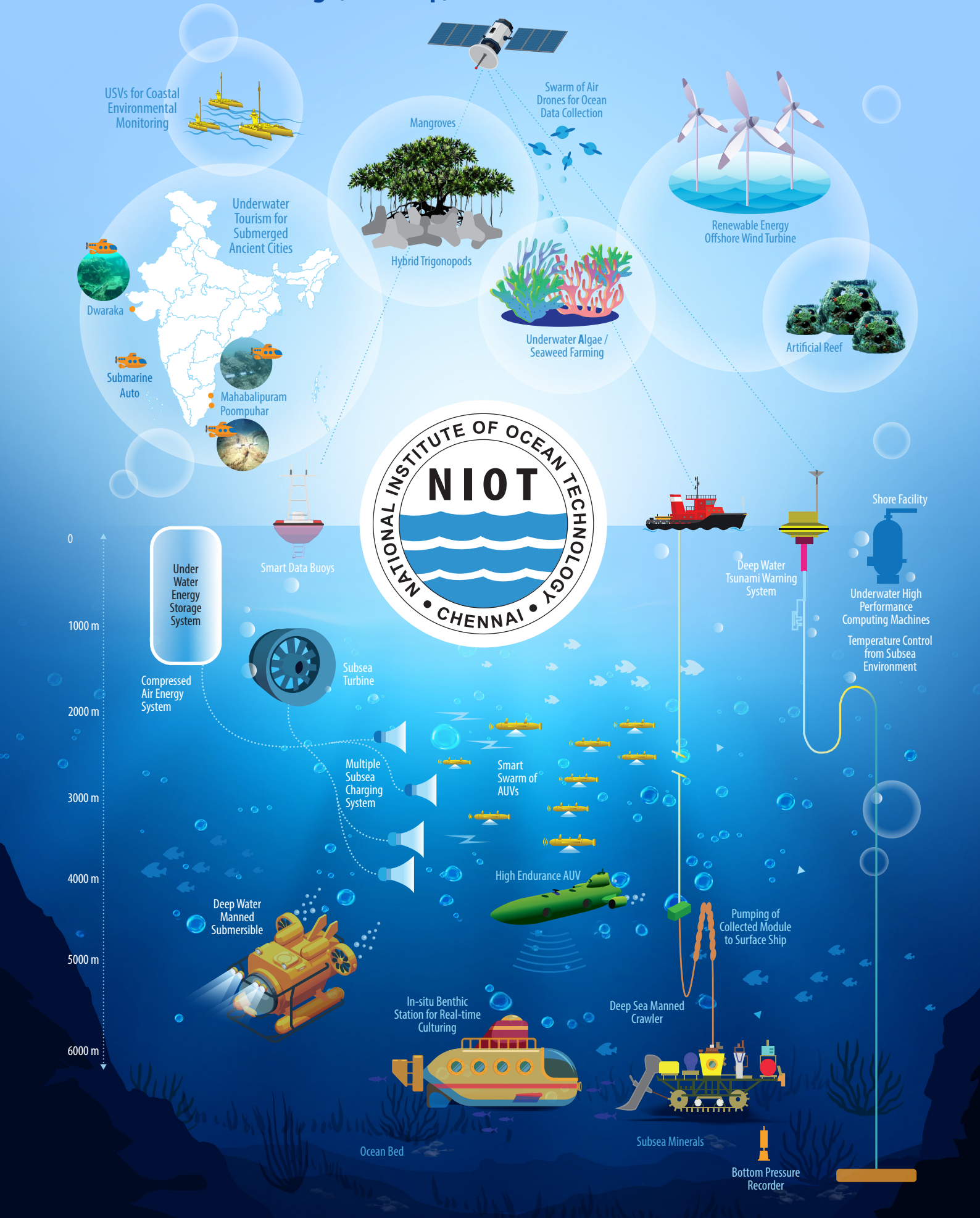
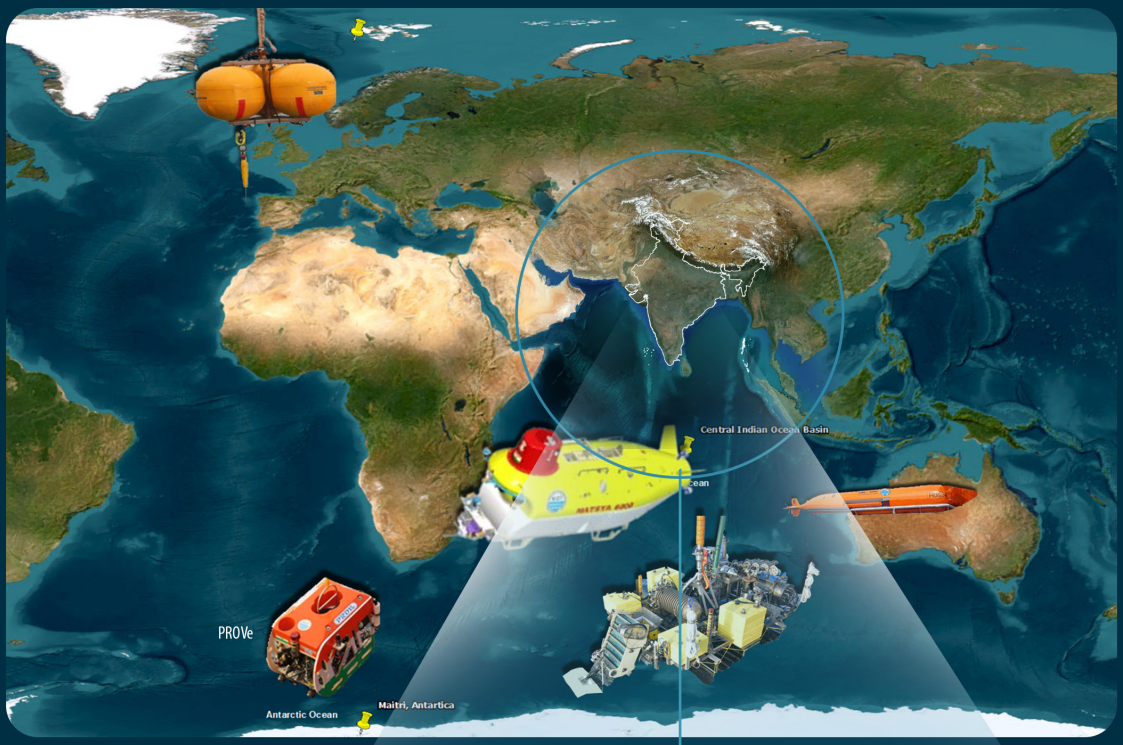
VISION 2047

Design, Develop, Demonstrate and Deliver



NIOT FOOTPRINT



NIOT
Chennai

ACOSTI
Sri Vijaya Puram

Chittedu
Andhra Pradesh

Pamanji
Andhra Pradesh

FOREWORD

Oceans are a vital part of our planet, covering more than 70% of the Earth's surface and playing a crucial role in regulating the climate, providing food and livelihood, supporting biodiversity, and driving economic growth. As we navigate the challenges of the 21st century, it is imperative that we recognise the importance of sustainable ocean management and harness the potential of our oceans for the benefit of current and future generations. I am glad that National Institute of Ocean Technology (NIOT), Chennai, a key centre of the Ministry of Earth Sciences has made this Vision-2047 document with the involvement of young scientists combined with NIOT's rich experience with key stakeholders such as researchers, academia, industrialists, policy makers, fishermen, etc.

The theme of this Vision 2047 document revolves around the 5 vital attributes of Food, Water, Energy, Climate Change and Ocean Health to promote economic growth while ensuring the health and integrity of marine ecosystems thereby addressing the United Nations Sustainable Development Goals (UN-SDG). By focusing on innovative solutions and actionable strategies, NIOT's vision to strike a balance between economic development and environmental preservation, thereby paving the way for a resilient and prosperous blue economy is commendable.

It gives me great pleasure to release the NIOT Vision 2047 document, which addresses the need to conserve and sustainably use the oceans, seas and marine resources for environmental, economic and societal development for a Viksit Bharat 2047.

I extend my best wishes for a successful and fruitful progress, and I look forward to witnessing the impactful outcomes of our collective endeavours in advancing the goals of ocean conservation and the Indian blue economy.

Dr. M. Ravichandran
Secretary – MoES

India's long coastline with a large Exclusive Economic Zone (EEZ) in addition to various deep seabed areas allotted by the International Seabed Authority (ISA), UN, make our sea area comparable to its land area which can contribute immensely to the Blue Economy and country's GDP.

With this background, the NIOT Vision–2047 document has been prepared with a mission 'To Design, Develop, Demonstrate and Deliver Technologies' for exploration and harvesting of Deep Ocean and Coastal resources to meet the future Food, Energy, Water, Ocean Health and Climate Change requirements through sustainable solutions.

This document combines the vast research experiences and inputs of Team-NIOT together leading to futuristic opportunities in association with industry partners, academia, various ministries and stakeholders of the Blue Economy of India. The vision document conforms to United Nations Sustainable Development Goals (UN-SDG) and no stone has been left unturned in this endeavour.

I am sure that the young team of NIOT shall strive relentlessly for enhancing the contribution of Blue Economy to India's GDP and will also ensure sustainability of the unique ecosystem surrounding the subcontinent. The rich experience of NIOT's contribution towards addressing stakeholders and marine societal issues has been seamlessly transferred to the future generations as apparent from this Vision-2047 document which goes a long way into making the Viksit Bharat a reality.

Prof. Balaji Ramakrishnan
Director- NIOT

OCEAN OF OPPORTUNITIES FOR BUILDING BLUE ECONOMY

India's EEZ, covering more than 2 million square kilometers, offers potential for both living and non-living marine resources that can drive economic growth and fulfills society's essential requirements - food, water and energy.

The challenges of changing climate, urge for sustainable harnessing of marine resources constantly pushes for innovative solutions in ocean technologies. This vision document of National Institute of Ocean Technology (NIOT) is built based on the three decades of excellence in Research and Development (R&D) in the field of ocean technologies to address the societal needs through a futuristic ambition. Given its vast experience, this comprehensive vision document shall place NIOT in a responsible leadership role in the coastal, deep ocean and marine front in terms of infrastructure, scientific knowledge base, technical know-how, capacity and competence.

With a large coastal population vulnerable to hazards, India needs suitable engineering infrastructure, warning systems, conservation of environment and safeguarding ecosystem.

It is pertinent to develop niche technologies that suit unique tropical dynamics and improve existing capabilities to harness these resources and ensure safety, including underwater vehicles and marine instrumentation for offshore operations. This vision document focuses on prioritising ocean technologies to meet these objectives.

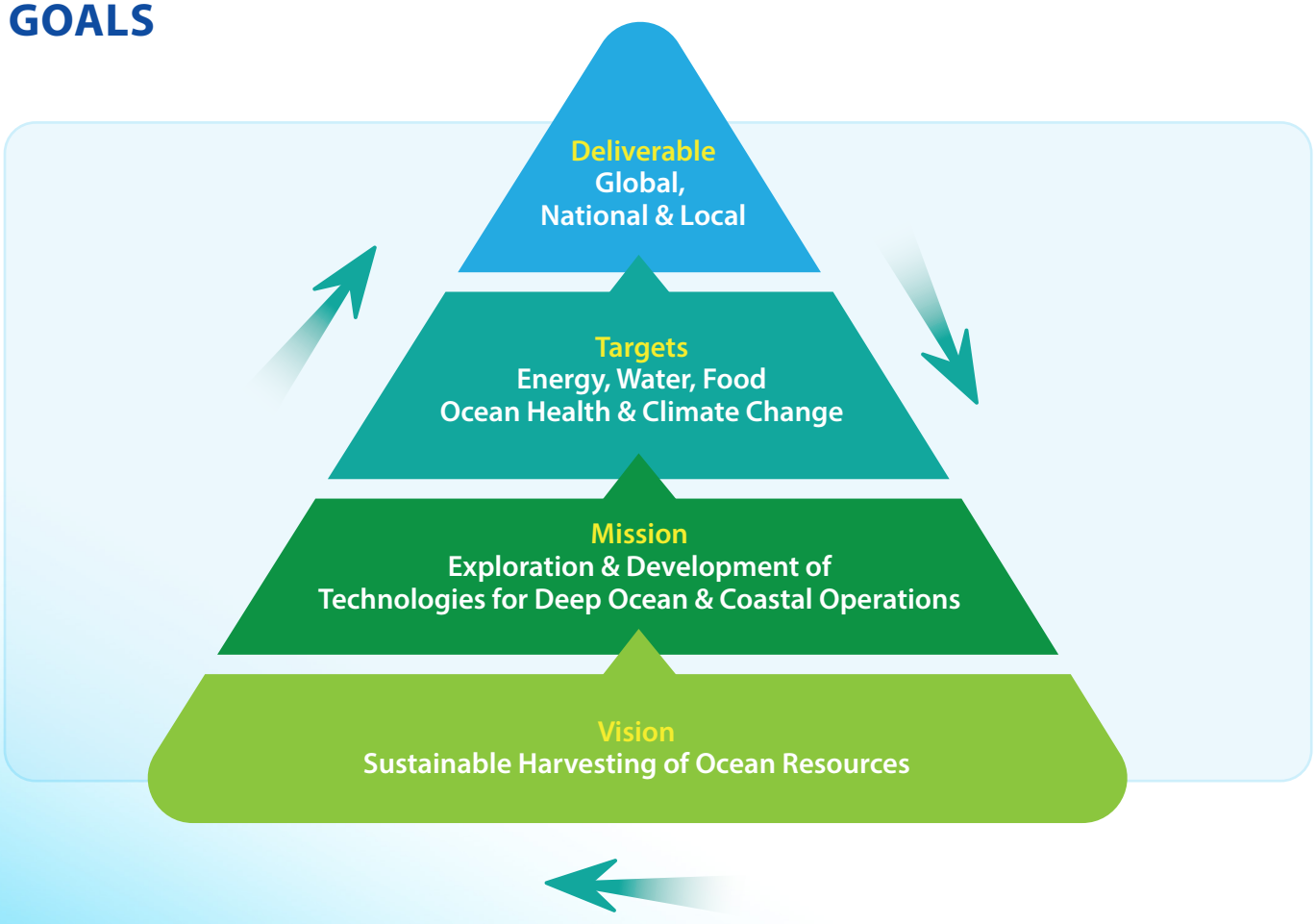
VISION

Sustainable utilisation of living and non-living marine resources in line with Viksit Bharat 2047.

MISSION

To design, develop, demonstrate and deliver technologies to explore and harness resources to meet future Food, Energy, Water, Ocean Health and Climate Change requirements.

GOALS



SUSTAINABLE ENGINEERING TO CONNECT SPHERES OF EARTH

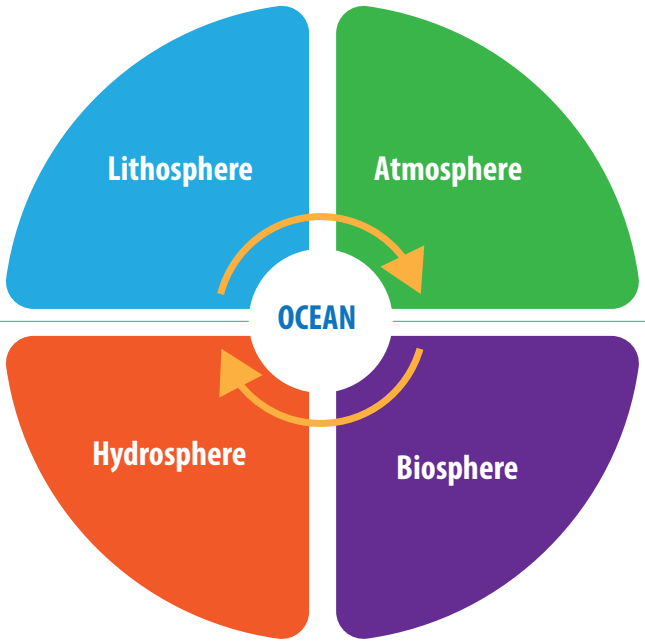
The unique nature of NIOT activities encompasses design and development of engineering solutions connecting all spheres of the Earth (Hydrosphere, Lithosphere and Atmosphere) and strives towards sustainable utilisation of marine resources (Biosphere), perfectly aligning with nature.

Exploration for Non-living Resources

Mineral and Marine Renewable Energies

Deep Ocean Research and Observations, Hazard Detection Desalination Energy Coastal Protection

Underwater Acoustics, Communications & Data Centre



Observations

Drones & Innovations
Arctic and Antarctic
Coastal Radars
Deep Ocean Lidars
Sensor Development

Exploration for Living Resources

Seaweed
Aquaculture
Biofuel
Marine Microbes

SYNERGY WITH SUSTAINABLE DEVELOPMENT GOALS

PATH TO OCEAN INNOVATION

The Deep Ocean Mission, launched by the Ministry of Earth Sciences (MoES), aligns with Sustainable Development Goal 14 (SDG 14) - Life Below Water, focusing on ocean conservation and sustainable resource use. It aims to enhance scientific research, build marine technology capacity, and explore ocean resources through innovative designs and operational platforms for deep-sea exploration. A major objective is developing technologies for mining mineral resources from depths up to 6000 metres, led by the NIOT, which advances subsea engineering and environmental research. Ocean-based renewable energy is another priority, including harnessing wave, current, thermal, and wind energy.

NIOT's ongoing initiatives support the Blue Economy by providing renewable energy, boosting local industries, and reducing climate vulnerabilities. These efforts contribute to multiple UN SDGs, such as clean water, affordable energy, and climate action. By 2047, India aims to be a global leader in ocean energy technologies, fostering economic and environmental sustainability. Marine technology development encompasses complex offshore structures for desalination and energy generation, including floating platforms, subsea conduits, and moorings. Research continues on underwater acoustic sensors, monitoring systems, and marine communication devices. NIOT focuses on manned deep-sea submersibles, deep-sea mining technologies, autonomous underwater systems, ocean gliders and aquaculture innovations such as submerged fish cages.

India's ocean research follows international benchmarks in data collection, coastal surveys, and marine environment monitoring. With cutting-edge research vessels and ocean observation platforms, efforts are underway to build climate-resilient coastal protection systems and develop advanced technologies like genome mining algorithms. These initiatives pave the way for a sustainable future driven by ocean-based science, technology, and resource management.

Given the vast R&D experiences, this vision document highlights NIOT's futuristics targets.

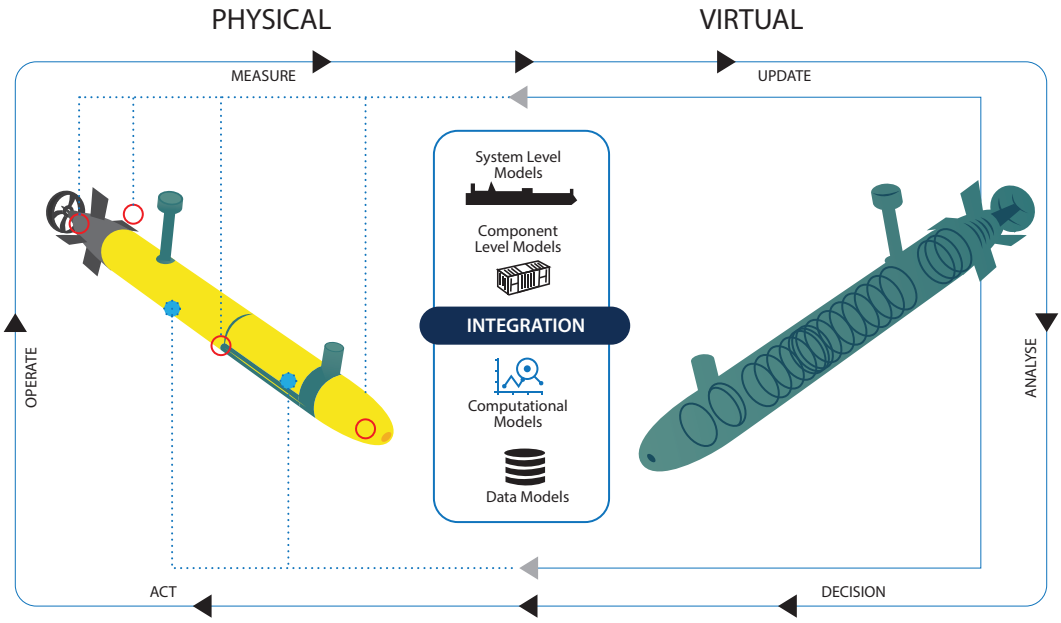
EXPLORING DEEP SEAS: ENERGISING NATIONS

(Deep Sea Manned and Unmanned Vehicles for Exploration and Harvesting of Resources)

Envisages intelligent / agile deep sea vehicles with autonomy for scientific explorations including blue / green energy resource development for harvesting of marine minerals. Strives to become global hub of excellence in deep ocean technology.

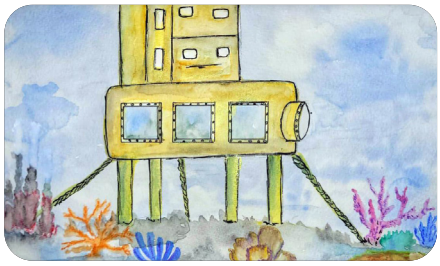
- Design and development of multi-dimensional manned and unmanned subsea vehicles for pioneering ocean research and underwater tourism. Scaling up for sustainable commercial utilisation of energy resources.
- Technology development for seamless communication system for surface to deep sea / underwater expeditions. Development of subsea farms of data centres and fully integrated systems for harvesting deep sea polymetallic nodules, gas hydrates & sulphides.
    - » Scaling up of the manned submersible for hadal depth
    - » Underwater human observatory
    - » High endurance Autonomous Underwater Vehicles (AUV)
    - » Subsea drilling and explorations

» Deep sea tourism
» Sustainable materials for deep sea applications
» AI-ML, Subsea docking and charging stations, Swarm Robotics
» Strategic underwater robotics
» Technology for Gas Hydrates exploration and extraction
» Prospecting and harvesting of subsea mineral resources
» Renewable energy sources to power deep sea systems

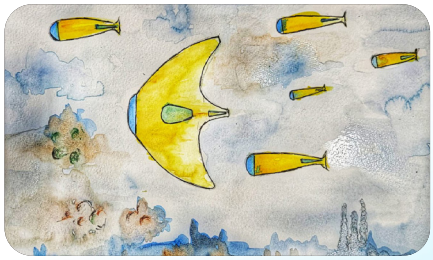


Digital Twin for Submersibles from Design to Life Cycle

Underwater Energy Storage



Underwater Observatory



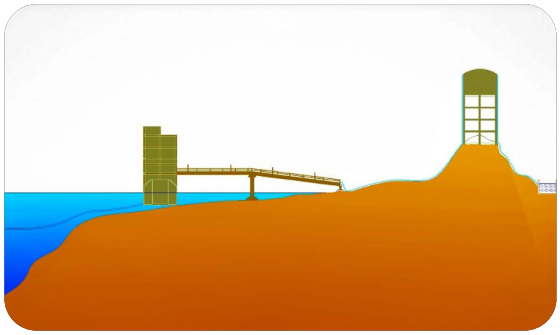
Swarm of Underwater Drones

WATER, FOOD AND ENERGY FROM THE OCEAN

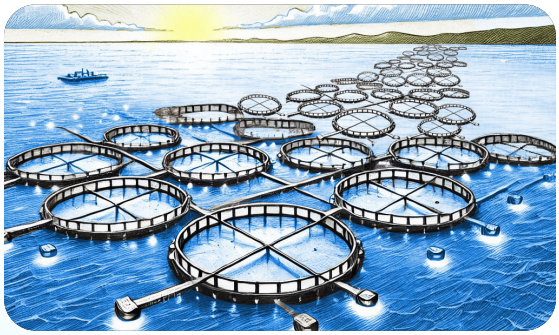
Farming the ocean to feed the nation through sustainable mariculture, providing potable water to remote, coastal and island communities and extracting affordable clean energy from the marine renewable resources. Innovation and infrastructure development for the deployment and maintenance of ocean energy devices, farms and plants. Creating self-sustaining ocean technologies for deep sea profiling and autonomous, aquaculture systems.

- Sustainable desalination for drinking water and agriculture in coastal regions and islands. Commercialisation of technologies for marine renewable energy from offshore wind, tide, hydrokinetic farms and salinity gradients.
  - » Scaled up ocean thermal energy conversion (OTEC) systems and hydrogen generation for commercialisation
  - » Energy efficient and sustainable desalination technologies
  - » Large scale offshore multi-tropic mariculture technology for farming, artificial upwelling to provide nutrient rich deep sea waters and coral stabilisers
  - » Exploration of deep sea ecosystems in real-time with automated AI based microbial phenotypes, profiling, genomics and metabolomics
  - » Pilot scale methane hydrate extraction technology for commercialisation
  - » Development of customised technologies for installation of floating / fixed structures, intake structures, submarine pipelines, moorings and risers
  - » Development of marine structures to demonstrate world-class technologies for applications in ecotourism, aquaculture, energy, desalination, coastal protection and climate stabilisation
  - » Infrastructure and capacity building for deep water fisheries, offshore handling and storage

OTEC - Energy and Desalination



Nutrient-rich Cold Water from Deep Sea for Agriculture and Cooling Purposes



Offshore Mariculture

Inputs from Energy & Fresh Water, Ocean Structures, Marine Bio-Technology, Gas Hydrates

COASTAL, OCEAN HEALTH AND CLIMATE CHANGE

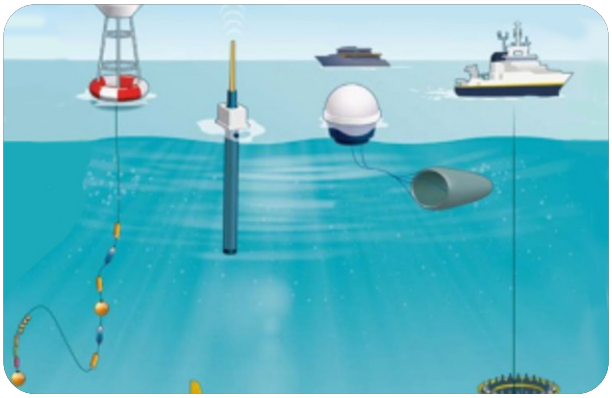
Creating resilient infrastructure for coastal communities, re-creating natural barriers against erosion and flooding through ecosystem and community-based approach. Addressing complex, ever changing atmospheric-oceanic coupled dynamic features such as climate trends, heat waves, extreme events. Establishing Swachh Sagar Mission for clean oceans and clean fishing harbours.

- Innovations to enhance safety, communication and resource efficiency for marine operations. Indigenous design, development and manufacturing of advanced oceanographic sensors and systems. Self-reliant marine sensor ecosystem for environmental monitoring and sustainable maritime activities.
- Advanced prediction models for simulation of climatic events and human interventions, commercialisation of indigenised technologies for oceanographic, offshore industries and environmental monitoring.
- Floating infrastructure for deep ocean technology demonstrations, Robust sensor networks for applications in port and harbour surveillance, underwater navigation, environmental monitoring and ensuring the sustainable management of ocean resources.
- Global commercialisation of indigenised technologies for oceanographic research, offshore industries, and environmental monitoring, with Public-Private Partnerships (PPPs) to stimulate economic growth and generate employment.
    - » Technologies for ecosystem restoration
    - » Coastal and offshore monitoring with interface for measurements of atmospheric and ocean parameters
    - » Coastal habitat reconstruction through climate resilient measures / strategies
    - » Automated exploratory and prediction systems using AI/ML techniques for marine ecosystems
    - » AI trained multi-decadal databases of coastal hydro and morpho-dynamics for predictions
    - » Advanced floating infrastructure for ocean surveys in the coastal and deep oceans
    - » State-of-the-art facility to develop, assemble, integrate, test and calibrate Ocean Observation Systems
    - » Self-sustaining ocean technologies, autonomous systems for deep sea profiling and oceanographic applications
    - » Integrated coastal beach safety system to monitor and model coastal oceanographic parameters, real-time updates on wave conditions, water quality, and beach safety
    - » Passive Acoustic Monitoring for ocean health, climate change and surveillance
    - » Platform for deep-sea observations operable depths beyond 2000 m, providing bio-geochemical data for climate and environmental monitoring
    - » Design and development of energy efficient underwater data centre
    - » Marine coastal ecosystem in blue carbon ecology balancing the photosynthesis, respiration, and remineralisation process

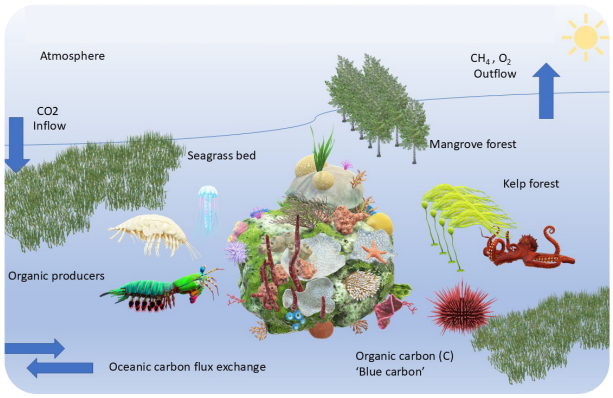
Inputs from Coastal & Environmental Engineering, Ocean Observation Systems, Ocean Acoustics, Ocean Electronics, Marine Sensors Systems, Sea Front Development

Met-Ocean and Environmental Monitoring

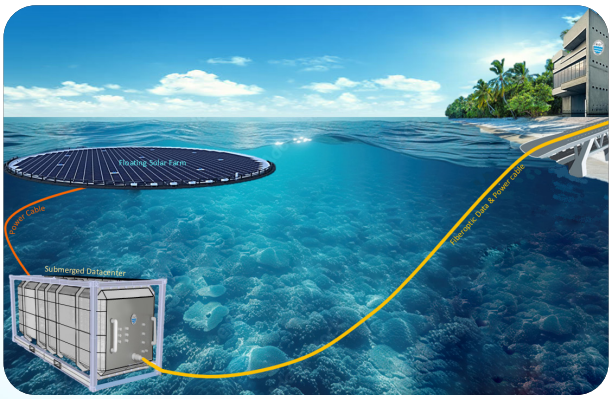
Coastal Resilience



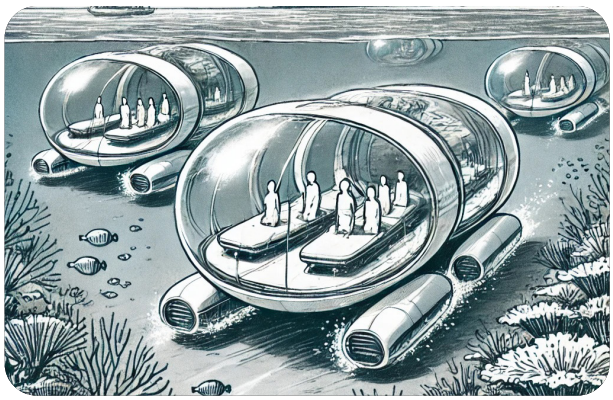
Ocean Survey



Blue Carbon and Coastal Ecosystem



Underwater Data Centre



Underwater Capsule

Inputs from Coastal & Environmental Engineering, Ocean Observation Systems, Ocean Acoustics, Ocean Electronics, Marine Sensors Systems, Sea Front Development

CENTRE OF EXCELLENCE AND INCUBATION

The technical know-how that NIOT has developed in the coastal and deep ocean studies over 30 years is unique in the country and worth setting up centres of excellence for transfer to the future generations.

With strong push for translational research, NIOT's technologies resulted in fruitful societal applications. The matured technologies scaled up to industrial production through collaborative transfer of know-how. NIOT's vision envisages to;

- Increased transfer of technologies for commercial production
- Scientific and consultancy services catering to societal needs like coastal protection, erosion mitigation, potable water supply (from LTTD), fisheries, aquaculture surveillance, seabed mapping, deep sea geotechnical investigations, underwater inspections and search operations
- Create an ecosystem for supporting and promoting incubation for startups to carry forward the long legacy of technical wisdom

PARTNERS

NIOT has entered into several Memorandums of Understanding (MoU) with internationally acclaimed universities, premier institutes, research organisations, industries as partners for collaborative research and development. It is envisioned to create an environment for ease of interactions that focus beyond immediate results to achieve the intended long-term goals.

The vision focuses on;

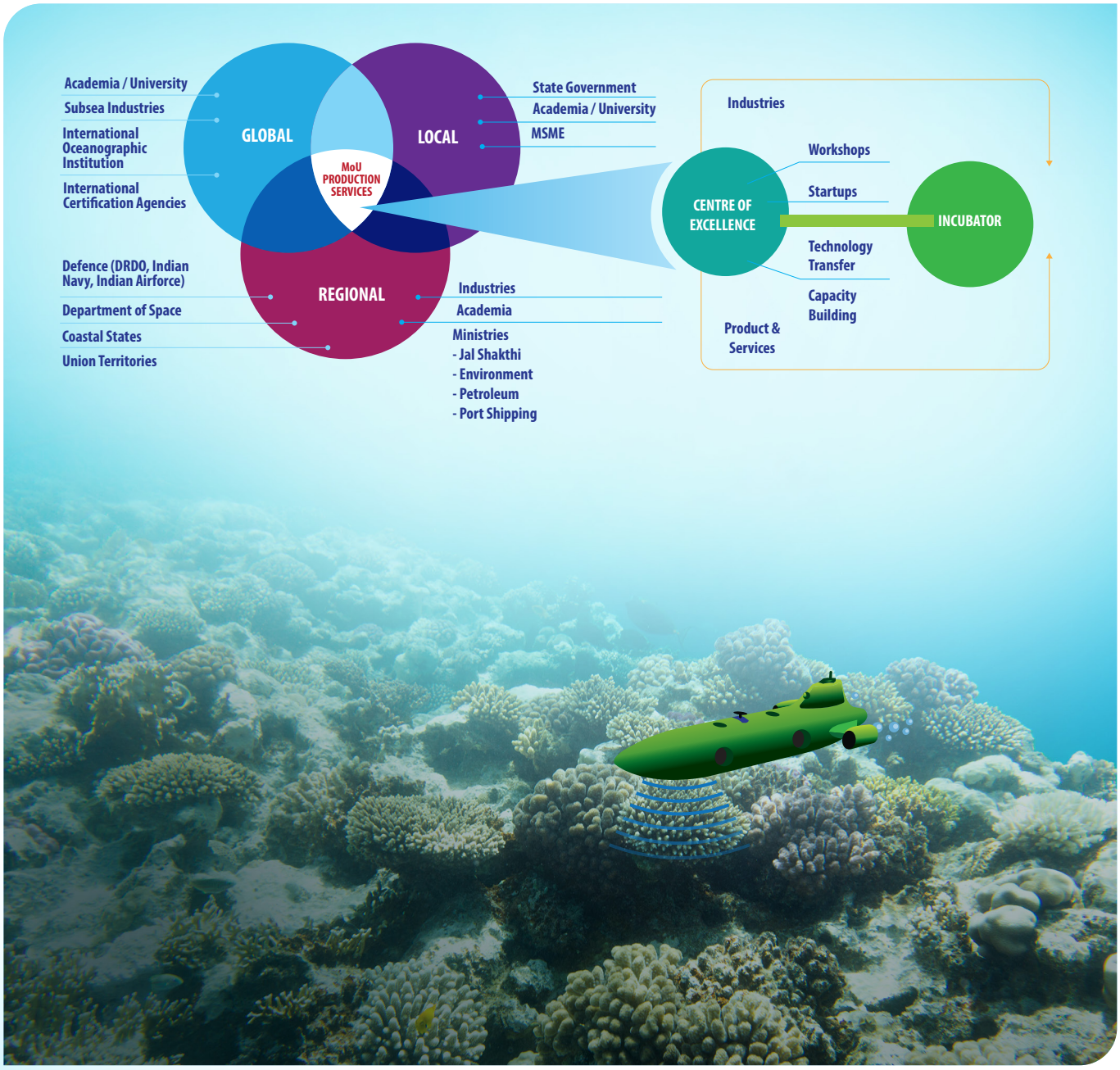
- Establishment of world-class test facilities for development of innovative technologies in the field of Ocean Engineering.
- Dedicated research on components, concepts and materials
- Creation of state-of-the-art testing and training facilities
- Capacity building by supporting research in related activities
- Training on creating start-ups, innovation centres using NIOT experience in designs, concepts and research output
- Development of systems, software and products

Research outcome has resulted in several technology transfers to industry

STAKEHOLDERS

For synergistic output and excellence, NIOT believes that collaboration with various ministries, state government departments and stakeholders leading to sustainable and far-fetched societal services for effective implementation.

Collaboration with ministries like Defence, Fisheries, Mining, Oil and gas, Disaster Management, Environment, Forests and Climate Change, Ports and Harbours, Department of Space, government departments of Coastal States and Islands of UT, stakeholders of the coast will be expanded to enhance expertise and enabling milestones.



Partnership with coastal states & UTs of Lakshadweep and A&N to resolve societal issues

NIOT

TECHNOLOGY, SERVICES, PRODUCTS

- **Deep Ocean Resource Exploration**
  - Minerals & gas hydrates
  - Seafloor coring
  - In-situ soil testing
  - Marine living resources
  - Ocean thermal energy conversion
  - Ocean surface mapping
- **Technology Development for Harvesting Deep Ocean Resources**
  - Autonomous underwater vehicles
  - Remotely operable vehicles
  - Flexible riser systems
  - Hyperbaric test facility
  - Submersibles integration
  - Integrated underwater mining machine
- **Development of Niche Technologies**
  - Manned & unmanned underwater vehicles
  - Transducers / sensors / imaging systems for underwater applications
  - Acoustic systems for ocean applications
  - Underwater drifters / profilers
  - Underwater acoustic test / calibration facility
  - Manned submersible simulator facility
- **Infrastructure Development and Industry Sponsored Projects**
  - NIOT campus at Chennai
  - *ACOSTI campus at Sri Vijaya Puram, Andaman
  - Seafront facility at Andhra Pradesh
  - Ballast water test facility at seafront
  - Coastal processes & management
  - Marine environment monitoring / conservation
- **Service to Society, Renewables / Sustainable Alternatives**
  - Coastal protection and shoreline conservation
  - Desalination *LTTD-shore based and offshore floating platforms
  - Solar based desalination
  - Open sea cages for marine farming
  - Sustainable harnessing of marine living resources
  - Current / tidal / wind energy
- **Operational Programs**
  - Weather and climate advisory services
  - Ocean observation network-moored data buoys
  - Tsunami buoy network
  - *HF radar/ tide guage network
  - NIOT fleet of research vessels
  - Seabed mapping (*EEZ)

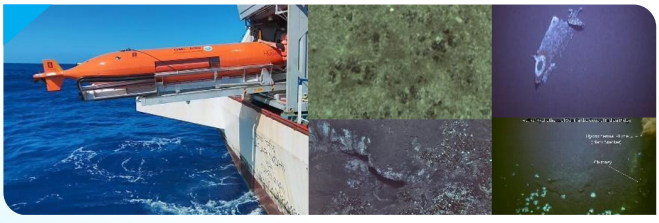
ACOSTI - Atal Center for Ocean Science and Technology for Islands, LTTD - Low Temperature Thermal Desalination, HF - High Frequency, EEZ - Exclusive Economic Zone

DECADE OF DYNAMIC GROWTH

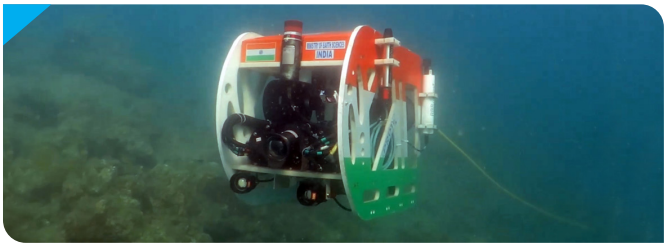
Under Deep Ocean Mission, human submersible Matsya 6000 is being developed as Samudrayaan.

Deployment and drilling operation of Autonomous Coring System (ACS) at Krishna Godavari Basin site in 1060m depths and coring upto 60m below the seabed.

Deployment of ROSUB 6000 for inspection of missing Indian Aircraft AN32 off Bay of Bengal.



Autonomous Underwater Vehicle (OMe 6000) exploration in Central Indian Ocean Basin (CIOB), Krishna Godavari basin, inspection of debris of the lost Indian Air Force - AN 32 aircraft in 2016, hydrothermal vents in Rodriguez Triple Junction.

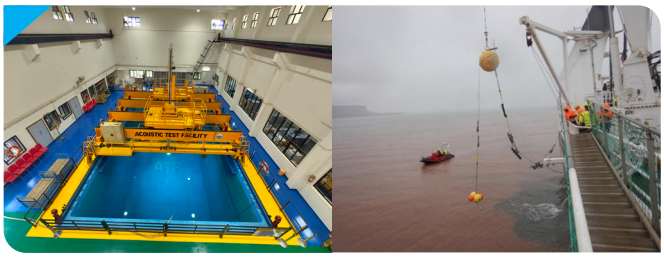


Use of 500m rated PROVe developed by NIOT in Andaman, Antarctica Indian barrier expedition and offshore Mangalore for biodiversity and coral reef studies.

Demonstration and collection of polymetallic nodules in a first of its kind mining trials off Nicobar in West Sewell ridge using VARAHA-3 in 1200m water depths.

Reliability enhancement tests of the nodule collecting mining system at 890 and 3420m water depths. First time in the world, locomotion trials of the Deep-Sea Mining System in 5270m water depths in the Central Indian Ocean. Slurry pumping trials with actual crushed nodules at 400m water depths. Sea trials of the self-propelled light-weight Seabed Mining Machine, VARAHA-1 in 3100m water depths at the Bay of Bengal.

Generating potable water through sustainable LTTD plants using innovative technology developed by NIOT in islands of UT-Lakshadweep Islands for small island communities.



NIOT has become the designated institute in underwater acoustics in India under BIPM Paris, a key test facility for hydrophone calibration. In-house development of passive acoustic system for polar region for systematic with continuous acoustic data collection along with Indian Arctic Moored Observatory (IndARC) since 2015 in the Kongsfjorden, Arctic for understanding climate change effects. Acoustic vector sensor array enhanced as an autonomous system and deployed in open sea for underwater source localisation. Winter sea ice melting in the Arctic found from acoustic records.

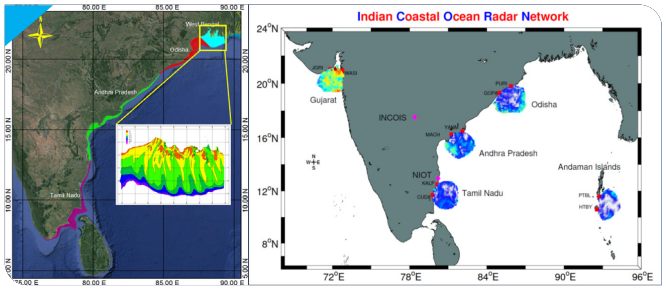
Innovative sustainable coastal engineering techniques have successfully restored beaches eroded in Tamil Nadu and Puducherry. NIOT has developed engineering designs for state departments to restore beaches and coastal inlets in Odisha, Tamil Nadu, Kerala, Andhra Pradesh and Goa. A next-generation Wave Atlas for the Indian coast, featuring 29 years of simulated wave data, has been released to provide design criteria for coastal structures.

Moored buoys measured the signals of more than 50 cyclones including extremely severe cyclone, Amphan, in May 2020 amid Covid lockdown and provides high frequency realtime data to India Meteorological Department for predicting cyclone tracks and intensity. Successfully indigenised Tsunami buoy system and is operational at strategic locations for early warning services.

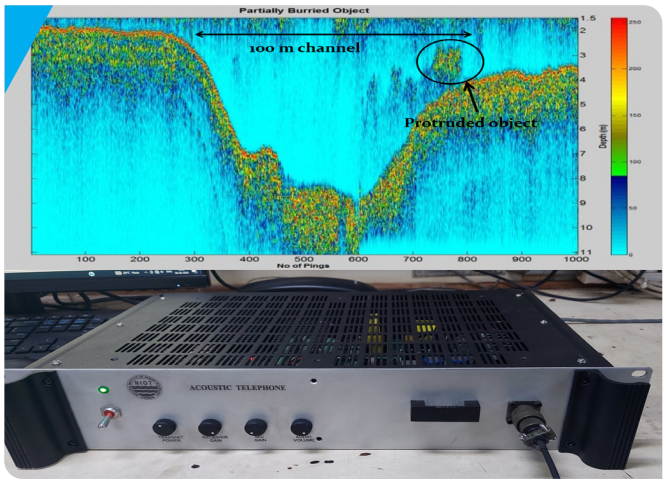
Microbial diversity profiling in deep seamounts of the Arabian Sea identified 814 microbes from 129 species, 69 genera, 38 families, and 26 orders, screened for enzymes and pigments. Developments include recombinant Ectoine for skincare, marine bacterial consortia for hydrocarbon bioremediation, and a technology to produce lutein from marine microalgae for treating age-related macular degeneration.

Indigenously designed, developed and demonstrated open sea fish cage with multipoint mooring system to increase fish farming.

Design and demonstration of small-scale hydrokinetic turbine in Andaman, wave powered navigational buoy with the integration of oceanographic instruments off Kamarajar port. A state-of-the-art laboratory for energy and fresh water generation is being used for optimisation. Saline water lantern developed in-house, technology transferred to industry for scaling up.

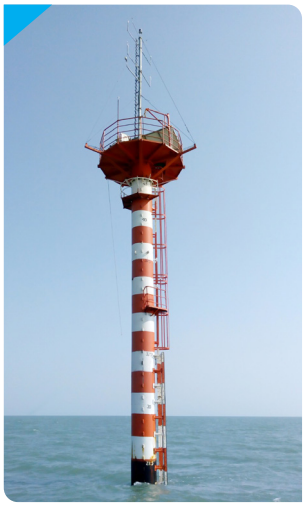


Mammoth coastal bathymetry data (0 to 30m water depths) collection along the East Coast of India, covering states of West Bengal, Odisha, Andhra Pradesh and Tamil Nadu. Operations and maintenance of High Frequency Radar for coastal observations.



Indigenously designed and developed digital processing based prototype Acoustic Telephone for two-way voice communication demonstrated in offshore Bay of Bengal at approximately 500m depth and indigenous acoustic sub-bottom profiler for shallow water application was developed and demonstrated off Chennai coast.

Indigenous design and development of Deep Sea Autonomous Underwater Profiling Drifter (DAUPD) float - successfully tested in 110m depth.



Deployment of buoy for offshore data collection using surface buoy with a deep-water mooring to obtain hourly data. Installation of offshore data collection platform at Gulf of Khambhat and Gulf of Kutch, for wind profile measurements.

Two new coastal research vessels - Sagar Tara and Sagar Anveshika commissioned under Make in India to monitor coastal ocean and its related research. Ocean Research Vessel, Sagar Nidhi successfully tracked the trajectory of the launch vehicle and GSAT 7 satellite links.

Development of seafront campus in Andhra Pradesh. First of its type Ballast Water Treatment Test Facility infrastructure dedicated to the nation.

TECHNOLOGY, PRODUCTS, SERVICES & FUNCTIONS

PARTNERS


Honeywell
Eco Build Cap
EBAD
wilo
BMTI
OIL SPILL COMBAT TEAM
HEXAGON
Unique Group
THE UNIVERSITY of EDINBURGH
SUZLON
CMFRI
USTDA
Aimil
TiNi
HBK
INCOIS
SIEMENS
leica
Toshniwal
JAMSTEC
Cnp Industries
CIBA
MacArtney
essen
VARYA
KSB
DEEPSEA
BIRNS
GT
Vizhinjam International Seaport
GUJARAT MARITIME BOARD
DNV
TRIDEL
KPL
OceanSITES
KANTEC
DATA PATTERNS
NATIONAL INSTRUMENTS
TEAM
ONGC
next
TECHNADYNE
ISRO

Notes

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Vision

Dr. M. Ravichandran, Secretary, MoES

Way Forward and Creative Inputs

Prof. Balaji Ramakrishnan, Director, NIOT

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VISION 2047 COMPETITION

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