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GUEST EDITORIAL

Why should India invest in deep ocean research?

The oceans are one of the three unique features of planet Earth, along with plate tectonics and the protective atmosphere covering the planet. The oceans are a key part of our lives and have excited the human mind for a long time. A better understanding of the oceans and their resources is necessary to maintain the delicate ecological balance in the ocean. The oceans are a storehouse of living and non-living resources, and have features at the seabed that have not been explored hitherto.

The oceans play a key role in the air we breathe, the water we drink, the daily weather and climate patterns, but we know very little about them. Our present knowledge of the oceans is mostly confined to shallow waters. The deeper waters still remain largely unexplored. More people have travelled to space than to the deep ocean realm. The global security issues involved with oceans dictate exploration of deep sea that needs specialized modern technology, which is not commercially available. Exploration of the ocean is an organized activity which includes rigorous observations and documentation of its physical, biological, geological and chemical aspects. It can reveal new sources for medicinal drugs, food, minerals and energy sources. Knowledge from such explorations can help predict earthquakes and tsunamis, and understand the possible impacts of global warming and climate change. It can inspire young people to seek careers in science and technology; and more importantly, science of the earth system in which we live and prosper. The great challenges of exploring the deep ocean will provide the basis for many technological innovations. India is surrounded by oceans on three sides. Our country's coastline is also very long (~7500 km) with around 30% of the population living in coastal areas.

Modern oceanography started in India with the establishment of the National Institute of Oceanography in Goa in 1966. The expansion in ocean-related activities demanded the establishment of the Department of Ocean Development (DoD) in 1982. Later, DoD was elevated to the status of a ministry and then as the Ministry of Earth Sciences in 2006, integrating the activities in atmospheric, oceanic and geosciences. These developments accelerated the strengthening of Indian expertise in ocean science and technology, marine geoscience, operational oceanography, exploration of marine living resources, and also led to the establishment of various research institutes, specialized in ocean science and technology. During the past two decades or so, these institutions have carved out a niche in specialized areas and have developed capability of providing skillful ocean services, building desalination plants and remotely operable vehicles and in the management of marine living resources, etc. India is now poised to take the next step to channel these developments in the areas of ocean science and technology to craft out socially, strategically and economically useful products and knowledge.

Considering the importance of oceans on the life and sustenance of humanity, the United Nations has taken steps to declare the period 2021–2030 as the *Decade of Ocean Science for Sustainable Development*. Further, the Sustainable Development Goal 14 (SDG-14) proposed by UN, which deals with life below the waters, emphasizes the importance of oceans in modulating and sustaining life. With this background, it is important to prioritize our efforts in ocean science and technology to achieve the national goal of transforming India to the third largest economy by 2030. The developments in ocean science and technology need to be further energized to support and fuel the marine and allied industries that will boost the blue economy of the country in the days to come.

In this scenario, the time has come for India to promote ocean-related research and development with a goal-oriented approach and societal impact as the prerogative. A focused approach in some of the areas, that have already progressed well, can make India a global leader and serve her national goals. For this, a mission-mode approach will pay the best dividends if the developmental efforts are restructured with adequate resources towards large-scale, result oriented projects rather than dealing with them as open-ended, locally distributed research at individual levels.

Through deliberations with the wide scientific community in the country, six major areas have been identified as part of a national task named 'Deep Ocean Mission'. These are: (1) development of technologies for deep sea mining, underwater vehicles and underwater robotics; (2) development of ocean climate change advisory services; (3) technological and conservational innovations for sustainable utilization of marine bioresources; (4) deep

ocean survey and exploration; (5) energy from the ocean and offshore-based desalination, and (6) krill fishery from the Southern Ocean. This mission will harness the already available expertise in the country, supplement their knowledge gaps, resolve the shortcomings and lead them to achieve larger goals at an accelerated pace. This mission should be an inter-ministerial programme that will need policy makers, industry, academia and research organizations, all contributing their individual strengths towards meaningful, larger deliverable goals.

India has two contracts with the International Seabed Authority for exploring polymetallic nodules and hydrothermal sulphides over the Central Indian Ocean, which may have huge economic benefits. To harness these resources, development of submersibles – manned and unmanned vehicles, mining systems to mine polymetallic nodules, cobalt crusts and sulphides are necessary, as these technologies are not available commercially. A manned submersible which can carry humans to the ocean depths combines the advantages of remotely operated and autonomous underwater vehicles, and will enable direct human observation and intervention. This will not only involve the development of underwater robotics, but also the associated sensors and acoustic communication systems. This will also empower the nation in the field of ocean exploration.

The global temperature rise has direct and indirect consequences on sea-level rise, inundation of low-lying coastal areas, extreme events and flooding. It can also have far-reaching implications on the biogeochemistry of the sea and life in the sea. Thus, it is important to assess and project the future changes in the ecological and physical properties of the Indian Ocean. Thus, the development of ocean climate change advisory service on mission mode assumes importance. To monitor the changes occurring in the ocean, deep ocean observations need to be taken up on a larger scale involving autonomous observing systems.

The deep sea holds the highest biodiversity on earth, which has hardly been explored. Biodiversity in the ocean holds utmost significance in today's quest for drug discovery utilizing deep-sea microorganisms. Hence the marine bio-resources, and their exploration and sustainable utilization will be a major theme of this mission. Investigations of deep-sea fauna and flora, capacity-building on deep-sea taxonomy and bio-prospecting are all envisaged as part of this programme. Bio-prospecting, a major component of this project, to be taken up with active collaboration of the Department of Biotechnology, will create many innovations, including the understanding of sustenance of life in the deep reaches of the oceans under high pressure, with no oxygen and sunlight, their genomics, and the discovery of medicinally active compounds and molecules.

There are a lot of sea bed features for which high-resolution maps are not available. Mapping of hydrothermal systems, accurate bathymetry of the Exclusive Economic Zone and the detailed survey for defending Indian rights on the seas surrounding us are all required. Accordingly, the field of deep-ocean survey and exploration assumes importance.

Living and non-living resources are important facets of the tremendous wealth that the oceans possess. Energy and freshwater are two such non-living resources that can be harnessed. Today the need for clean, green and renewable energy is well recognized, and efforts for harnessing all forms of renewables from the ocean like ocean currents, ocean thermal energy conversion, and offshore winds are essential. Similarly, the desalination of seawater can play a major role in the oceans augmenting water sources in the coastal regions. While several technologies for desalination are being implemented, the need of the hour is to develop new technologies which have minimal environmental issues and can be self-sustaining for power. To this end, a desalination plant should be taken up, with power also from the ocean. Lastly, living resources in the form of krill fishery need to be considered as a proof-of-concept project. The Indian sector of the Southern Ocean is available for harvesting krill, but it has to be proved as a viable concept through the assessment of harvestable potential in that area.

The marine environment is under threat from climate change, pollution and over fishing. Development and deployment of autonomous vessels and other emerging technologies like marine biotechnology shall create a new generation of economic activity. Oceans support tourism, livelihoods and trade. It is vital that, as a nation, we are able to proactively respond to these changes, and be prepared to meet new challenges and take advantage of new opportunities. We need to grow our marine and maritime economy, tackle climate change and pollution, and improve the sustainable use of ocean resources on a mission mode.

This mission can lead to a revolution in the understanding of the oceans around us, and make India a pioneer in several technological fronts and also lead to security and self-sufficiency of the nation as a whole. The mission proposes to explore the deep ocean similar to the space exploration started by ISRO about 40 years ago. Through this mission, we should aspire to bring a similar revolution in the use of ocean science and technology to shape the life and developmental activities of the country. Hence we need to make appropriate investments in deep ocean exploration and research. Exploration of the ocean will fetch more dividends in terms of socio-economic benefits than space exploration.

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