

Concept Note for E-Learning Modules on Sediment Management in the Tropical Waters of the Indo-Pacific

The entire global community is looking at the Indo-Pacific region as the theatre for strategic interaction. The geopolitical and geostrategic attention is also accompanied by massive mobilization and strategic security concerns. This attention also demands that we are able to harness the economic and political potential, these geographies offer. The Indo-Pacific region by definition is the tropical waters of the Indian Ocean and the Pacific Ocean. The tropical water presents, unique characteristics, in terms of the sediment transport and content. Effective management of the sediments will have far reaching impact across varied applications, ranging from management of floods, erosion, transportation, fisheries, aquaculture, sustainability, underwater resource extraction, and more. Digital transformation manifested as Marine Spatial Planning (MSP), in the underwater space can be a game changer and will allow effective governance mechanism. Real-time appreciation of the underwater domain will allow well informed policy interventions. Human centric approach for the coastal and riverine communities will go a long way in bringing inclusive growth for all.

The Government of India, on its part has demonstrated significant seriousness in driving marine and freshwater ecosystems for sustainable development. Multiple mission mode projects, like Sagarmala, Bharatmala, Gati-Shakti, Jal Jeevan, Inland Water Transport and more have been announced and aggressively pursued. However, these mega projects also face massive challenges in managing the siltation and the erosions, particularly due to our tropical waters. Climate change risk has become real, and we need to guard against extreme weather events like floods, droughts, cyclones and more, leading to erosions and large-scale loss of life & property. The solutions to such site-specific challenges lies in effective sediment management, customized to the unique tropical characteristics. Sediment management can be looked at from two broad dimensions. The first is the sediment transport study in the rivers/lakes, ports and also in the coastal regions to manage excessive siltation and erosions. The second dimension is the sediment classification from three broad outlook. The first is the sediment bearing pressure assessment to ensure efficient construction activities in the underwater space, along with deployment of heavy platforms or equipment's. The second is the benthic ecosystem assessment to manage any sustainability concerns and also extract maximum benefit out of the ecosystem that exists. The third is the assessment of abiotic content including high value minerals and also unwanted pollutants.

The Maritime Research Centre (MRC) Pune is actively developing the Underwater Domain Awareness (UDA) Framework, that encourages pooling of resources and synergizing of efforts. Furthermore, this framework has the potential to foster cooperation among regional nations and deter external powers. India can solidify its leadership role by positioning itself as a capacity and capability building partner in the

region. It is imperative to ensure that the nation's decision-makers and stakeholders are aware of both the challenges and opportunities in this regard.

The Capacity Building Commission (CBC) is spearheading an effort to unlock the full potential of the blue economy in the tropical waters of the Indian Ocean Region (IOR) and beyond. This initiative holds the key to genuinely realizing the SAGAR vision. The UDA framework, comprising policy and technology interventions, along with the development of acoustic capacity and capabilities, will be the driving force behind this undertaking. The preceding ten modules were geared towards comprehending the extensive UDA framework and its main application areas. This series of twelve advanced modules will focus on meeting the specific needs of sediment management to ensure effective governance in the unique tropical waters.

Proposal

To begin, it's crucial to educate stakeholders and policymakers about the relevance and nuances of sediment management. Therefore, there are plans to introduce a series of E-learning modules designed to offer convenient and efficient knowledge enhancement for the participants. These modules will encompass a wide range of topics related to building capacity and capability for the advancement of sediment management in the coastal and freshwater systems in the tropical waters. The intended beneficiaries of these modules encompass policymakers at the national, state, and local levels, as well as community representatives, support organizations, on-ground foundations, regulatory bodies, and enforcement agencies. Here is a list of all seventeen modules:

Modules

(a) Basics of Sediment Management.

Sediment controls the physical habitat of underwater ecosystems. The seabed/riverbed contains resources of socio-economic, environmental and geomorphological importance. As much as 40% of the world's recoverable oil resources may lie offshore. The transport and distribution of sediments play a major role in understanding habitat structures, ecosystem function and harnessing the economic minerals. The module will briefly outline the importance of sediment management.

(b) Challenges and Opportunities.

India is blessed with a coastline stretching over 7,500 kilometers and an extensive river network in its heartland. This presents an opportunity for the emergence of fresh industries and the generation of innovative concepts in various sectors, including water resource management, sediment transport, dredging, biodiversity preservation, coastal management, and the blue economy. However, the complex inland water systems, which carry substantial sediment loads from the mountains, coupled with the distinctive characteristics of the terrain, pose challenges for the establishment of effective technological and governance systems.

(c) Tropical Waters and the Unique Characteristics.

The tropical waters of the Indo-Pacific region, present unique characteristics on multiple fronts, including biodiversity and underwater resources. The sediment transport pattern is also unique and thus sediment bedload assessment requires nuanced approach. The acoustic survey process deployed for underwater assessment suffers sub-optimal performance of the order of 60%. This is a serious limitation, as any Underwater Domain Awareness (UDA) effort, is highly resource intensive and demands specialized knowhow.

(d) Sediment Transport Studies.

In tropical waters, sediment transport and distribution at the land-water interface have significant impacts on the dynamics of coastal zones, rivers, and estuaries. Sediment transport studies are critical for managing varied applications, namely inland water transport, water resource management, water quality management, fisheries, aquaculture, coastal management and more. Studying the sediment bedload dynamics facilitates comprehension, thereby ensuring enhanced management. In this module, we discuss the why, how and for whom.

(e) Sediment Classification.

A comprehensive analysis of the sediment is vital for understanding the bedload structure, particularly through sediment classification. Effective methods for sediment classification are crucial for calculating sediment-bearing pressure, which is essential for offshore construction and exploration projects. Benthic ecosystems, consisting of organisms living at the bottom of the water bodies, serve as indicators of environmental well-being. The deep oceans hold significant reserves of valuable rare minerals, including rare earth elements, precious metals, lithium, and uranium. The discovery of abiotic elements in the sediment is vital to understanding makeup, movement, and geological processes in this vast underwater area. In this module, we discuss the why, how and the broad nuances.

(f) Sediment Bearing Pressure.

Sediment bearing pressure, is a key requirement for any underwater deployment for static and dynamic structures. The static structures like bridges, jetties, rigs, etc., require precise sediment bearing inputs. Dynamic deployments like heavy platforms, vehicles, etc., also need to be aware of the sediment bearing pressure, to ensure stability and avoid accidents. Undertaking such studies for each deployment, may be extremely inefficient. In this module, we discuss the specific applications and their why and how. Varied case studies will be presented that highlight the unique field conditions and their management requirements.

(g) Benthic Ecosystem Management.

The benthic ecosystem is fundamental to the well-being of the water bodies and their sustainability. However, they are the least understood and ruthlessly violated. It not only destroys their own survival, but also the survival of the entire underwater and above water ecosystem. Economic loss can be substantial across varied sectors, like fisheries, aquaculture, mining and more. Indiscriminate dredging and similar activities have a deep impact on the benthic eco-system; however, they do get prioritized in any

of the Environmental Impact Assessment (EIA) studies. The traditional practices have high value in conserving the benthic ecosystems and thus we need to evolve ways to map the modern tools to the traditional practices.

(h) Abiotic Assessment & Management.

The underwater domain, boasts of mineral resources, raw material for construction activities, rare earth metals, etc. Extraction of these resources is not straight forward, as it can have massive sustainability impact and also may not be economically viable. Effective planning and management will depend on the precise assessment of the quantity and distribution. The module will focus on the how, why and for whom of abiotic assessment and management.

(i) Inland Water Transport.

The Inland Water Transport is an ambitious mission mode project announced by the Government of India. The vast network of rivers across the country will be utilized for multi-modal connectivity and efficient logistics. However, the complex sediment transport pattern in the tropical waters is a major cause of concern for navigability of these waterways. Such a massive project also has serious sustainability and climate change risk issues to be managed. The module will focus on the specific challenges and opportunities related to the Inland Water Transport.

(j) Water Resource Management.

India as a country receives 4% of rainwater, whereas it has to serve approximately, 18% of the global population. As we speak, we are 20% water short, and also if the present trends are to be believed it could get worse in the near future. The water resource distribution is even more skewed and the densely populated northern regions are having severe water scarcity. The sediment transport appreciation is critical to ensure effective management of urban flooding, storage capacity, erosion, etc. This will module will focus on the how, why and for whom. The specific challenges and opportunities in water resource management will be discussed.

(k) Water Quality Management.

The water shortage is a concern; however, the bigger worry is of the quality of water available and also the lack of calibrated water availability to the users. The vast water bodies suffer from varied biological and chemical contamination. In the absence of real-time monitoring of the water quality, could be a serious public health and safety concern. This module will focus on the how, why and for whom. Digital transformation will be extremely critical for ensuring real-time monitoring and nuanced policy intervention.

(l) Coastal Management.

The marine resources of the Indian Ocean can serve as a crucial driver of India's economic growth. Coastal management encompasses initiatives like habitat conservation initiatives of benthic assemblages, early warning systems, developing tourism infrastructure, restoring water bodies, beach cleanup, and more. Effective coastal management can foster community development and promote inclusive

governance by adopting comprehensive approaches. This, in turn, encourages local community participation and ensures good governance, which is vital for sustainable and inclusive development.

(m) Sagarmala.

The Sagarmala Project is a bold endeavour, undertaken by the Government of India, inaugurated in 2015. The main goal is to facilitate the development of ports throughout the Indian coastline. Sagarmala plays a crucial role in sediment management, especially in dredging and the upkeep of nautical channels in ports and harbours. The dredging process may result in adverse environmental impacts, including the disruption of marine ecosystems and the possible alteration of water quality. Effective sediment management systems in ports and harbours are crucial for minimizing adverse effects and ensuring ecologically responsible dredging operations.

(n) Policy Interventions.

The Indian Ocean Region lacks advanced technologies for effectively monitoring, controlling, and comprehending sediment-related issues. Inadequately implemented regulations and laws have led to numerous natural challenges that require urgent resolution. To address existing policy gaps, it is essential to identify them clearly and establish a comprehensive policy framework that can bring greater coordination and structure to these efforts. Based on the policy gaps, specific regional, national and local policy interventions need to be devised.

(o) Technology Interventions.

The existing methods for evaluating and tracking sediment movement and its impact on the seafloor are both laborious and ineffective. The urgent requirement of the moment is to use sophisticated techniques such as repurposing sediment for activities like beach replenishment, land reclamation, and construction and implementing Internet of Things (IoT) sensors and monitoring systems in aquatic environments to provide up-to-the-minute information on silt levels, water quality, and environmental factors. Collaboration between educational institutions, government organizations, and companies is necessary to improve skill development and bring value to the workforce. This collaboration will also help bridge the gap between academic degrees and industrial requirements.

(p) Acoustic Capacity & Capability.

The field of acoustics revolutionizes our knowledge of sediment composition and movement. India should prioritize investment in R&D initiatives to create and evaluate acoustic sensors, platforms, and data processing tools specifically for tropical waters. Creation of training programmes aimed at instructing professionals and academics on the methodologies used to measure acoustic sediment. Furthermore, it is necessary to engage in partnerships with universities and research institutes to provide specialized academic curriculums in underwater acoustics, hardware development, and data analytics.

(q) Digital Transformation.

We can better understand the ocean floor by merging advanced technology, machine learning, artificial intelligence, and the Internet of Things with current systems. As the scope and applications expand, it's now essential to pinpoint the limitations and technical expertise needed and integrate them into a comprehensive development strategy. This will involve investing in region-specific R&D, combining UDA, Marine Spatial Planning (MSP), and skill development frameworks to align with economic demands and the UN Sustainable Development Goals (SDGs). This would include developing comprehensive information systems that integrate data from various sources, including sediment monitoring systems, dredging operations, and environmental data, to facilitate data-driven decision-making.

The Potential Participants

The potential participants for the E-learning modules will include:

- (a) The Fisheries Department.
- (b) The Water Resource Departments.
- (c) The Public Sector Undertakings (PSUs).
- (d) The Administrative Training Institutes under the Government of India.
- (e) Maritime Boards in all the nine Coastal States.
- (f) Environmental Regulators and Disaster Management Authorities.
- (g) Energy Regulators
- (h) Surface Transport Departments & Regulators
- (i) Auditors and Science & Technology Departments

The participants will be provided with a significant amount of reading material, along with the presentation in the form of a video. The MRC runs a digital platform, the UDA Digest, with four forms of contents. A series of **commentaries** (800 words) to highlight some basic aspects, short articles (1500 words) referred as **issue briefs**, presenting easy-read content for quick appreciation of the UDA framework and its varied aspects. The third form of content is the rigorous **expert articles** (3,500 words) with proper referencing and analytical reasoning. Finally, the **short reports** are 10,000 words, a serious piece of research output with references and detailed scientific and analytic effort. These are all peer-reviewed by the specific subject matter expert and the in-house research team.

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