

Webinar Report

UDA Framework-Based Sediment Management in the Tropical Waters of the Indo-Pacific Strategic Space

Held on: 08 April 2026

Executive Summary

On 08 April 2026, the Maritime Research Center, in collaboration with Nirdhwani Technology Private Limited, hosted a webinar on **‘UDA Framework-Based Sediment Management in the Tropical Waters of the Indo-Pacific Strategic Space.’** This webinar was attended by top-tier experts, and the core presentation was delivered by our Research Fellow, Romit Kaware from IIT Delhi. With over three years of dedicated research in sedimentation and siltation, he highlighted the critical importance of sediment management across coastal, freshwater, and watershed systems and its far-reaching impact on people, the economy, and nature. Our Founder & Director, Dr (Cdr) Arnab Das, set the context in his opening remarks by emphasising the unique challenges of tropical waters in the Indian Ocean Region and the urgent need for informed technological and policy interventions. The session convened leading experts from the maritime, hydrographic, and strategic communities to deliberate on the growing significance of sediment management in the region.

Distinguished experts, including Rear Admiral Y. N. Jayarathna (Retd), Former Chief Hydrographer, Sri Lanka, Vice Admiral Adhir Arora (Retd), Former Chief Hydrographer, India, Dr Amit Rajan, Research Fellow at the Institute of South Asian Studies, NUS Singapore, and Dr R. Chandrashekhar, Strategic Analyst, further deliberated on the topic. The session concluded with insightful remarks from Ambassador Anup Kumar Mudgal, MRC Strategic Adviser, who highlighted the growing relevance of sediment management in the Blue Economy. The discussion emphasised the strategic and economic importance of sediment management and underscored the need for collaborative mechanisms, including shared data platforms and accessible regional databases, to support informed decision-making across the Indian Ocean Region.

A major theme throughout the webinar was the increasing relevance of interdisciplinary solutions. Participants stressed that sediment management extends beyond scientific and engineering concerns, encompassing geopolitical, environmental, socio-economic, and governance dimensions, particularly in transboundary river and coastal systems. The webinar also explored the broader climate-security relationship, emphasising that environmental degradation and unsustainable coastal interventions can have long-term strategic and humanitarian consequences. Experts advocated for a balanced approach that combines scientific rigour, policy coordination, environmental sensitivity, and regional cooperation to ensure sustainable underwater and maritime development. Overall, the webinar reinforced the importance of the UDA Framework as a comprehensive mechanism for integrating scientific

knowledge, technological innovation, and policy planning to support underwater ecosystems and sustainable growth across the Indo-Pacific Strategic Space.

Full Webinar Video here - <https://youtu.be/jOqUIbfhkS8>

Background and Context

The movement of sediment plays a critical role in shaping tropical shallow waters in both marine and freshwater systems, a process influenced by monsoon-driven hydrodynamics, high riverine sediment discharge, and complex seabed morphology.

Conventional sediment management approaches are often based on localised, reactive hydrographic surveys that are time- and cost-intensive and fail to capture the spatial and temporal variability of sediment processes.

In rapidly developing coastal economies in the Indian Ocean Region (IOR), such as India, Sri Lanka, and Bangladesh, ineffective sediment management exacerbates challenges, including port siltation, reduced navigational depth, increased urban flood risk, and degradation of sensitive benthic ecosystems.

Need for an Integrated Framework

Addressing these challenges requires an integrated, data-driven framework that combines advanced monitoring technologies and predictive modelling. Within a broader Underwater Domain Awareness (UDA) framework approach, acoustic sensing and remote monitoring can enable sediment classification, seabed mapping, and assessment of sediment-bearing pressure, which are essential for offshore infrastructure stability, submarine cable routing, and seabed suitability analysis.

UDA-Driven Sediment Monitoring Framework

The proposed framework shifts the focus from conventional sediment strategies to holistic UDA-driven sediment management by integrating three core pillars of digital monitoring:

1. **Acoustic Sediment Classification:** Utilising underwater acoustics to determine seafloor composition and sediment characteristics (e.g., grain size, porosity), providing the ground truth data for sub-surface conditions.
2. **Satellite-Based Sediment Concentration:** Leveraging remote sensing to monitor Total Suspended Solids (TSS) and turbidity plumes across vast tropical coastal expanses.
3. **AI-Based Sediment Transport Prediction:** Deploying machine learning models to simulate and predict sediment movement under varying hydrological conditions and flow patterns.

Proposed Technical Application of the Sediment Monitoring Framework

1. **Sediment Classification and Seabed Mapping:**

- a. Acoustic classification of seabed sediments based on grain size, density, and roughness
- b. Identification of sediment types for dredging, disposal, and beneficial reuse
- c. High-resolution mapping of sediment distribution for coastal and offshore engineering projects

2. Sediment Bearing Capacity and Seabed Stability:

- a. Assessment of sediment-bearing pressure for offshore structures and seabed-mounted systems
- b. Evaluation of foundation stability for offshore platforms, wind turbines, and subsea installations
- c. Identification of weak or mobile sediment layers that may affect infrastructure performance

3. Maritime Infrastructure

- a. Assessment of sediment-induced loading on offshore structures
- b. Seabed suitability analysis for submarine cables and pipelines
- c. Long-term bathymetric stability analysis

4. Port and Navigation:

- a. Optimisation of dredging schedules based on sediment transport predictions
- b. Maintenance of navigational channels and port basins

5. Watershed Management and Urban Flooding

- a. Identification of sediment accumulation zones in river mouths and estuaries
- b. Improved sediment budgeting for catchment-scale management

What were the main objectives of the webinar?

The webinar aimed to:

- Highlight the strategic and economic importance of sediment management for India's Blue Economy
- Present a UDA-based framework that integrates acoustic, satellite, and AI data streams.
- Demonstrate the necessity of understanding unique tropical conditions for accurate modelling.
- Introduce an MSP-based tool that incorporates socio-economic factors for balanced coastal development
- Explore digital transformation pathways for dredging and disaster management

Speaker-wise summary of discussions:

Dr (Cdr) Arnab Das, Founder and Director, Maritime Research Center (MRC)

Dr (Cdr) Arnab Das highlighted the importance of an integrated UDA Framework for effective sediment management in tropical waters. He emphasised that sediment management is no longer a scientific concern, but also a strategic, environmental and economic priority for the IOR. He explained that the UDA Framework combines policy, technology, and capacity-building interventions to address the challenges of fragmented marine data. He further noted that the framework integrates acoustic sediment classification, satellite-based monitoring, and AI-driven predictive modelling to improve understanding of the seabed and of sediment transport.

He noted that conventional sensor-based monitoring alone is insufficient for managing large maritime spaces such as India's 3.7 million sq. km Exclusive Economic Zone (EEZ). To overcome these limitations, the MRC advocates the use of modelling and simulation tools that can provide enhanced situational awareness and near-infinite analytical resolution. One major theme of his intervention was data sovereignty and maritime security. He stressed that while hardware and sensing technologies may be sourced globally, the analysis, the interpretation, and management of strategic maritime data must remain within the country to avoid security vulnerabilities and preserve long-term strategic advantages. Additionally, he called for sustainable sediment management practices rather than "ruthless dredging," while highlighting MRC's efforts to build the capacity of diverse stakeholders, including security agencies, researchers, and coastal communities, under the broader UDA Framework.

Watch the full video now: <https://www.youtube.com/watch?v=UnBkIG08Ego>

Romit Kaware, Research Fellow, MRC

Our Research Fellow, Romit Kaware, presented on "**Integrated and Data-Driven Approach to Sediment Management in Tropical Waters under the broader UDA Framework.**" His presentation called for a transition from reactive dredging practices to proactive, scalable, and cost-effective sediment management solutions for the IOR. He explained that the UDA Framework combines acoustic data, satellite imagery, and AI-driven predictive modelling to monitor sediment dynamics across riverine, coastal and reservoir systems. His session also explained the growing sediment-related challenges in the region, including port siltation, navigational constraints, loss of reservoir storage, and impacts on fragile benthic ecosystems, particularly in high-sediment-influx zones such as the Ganga-Brahmaputra basin.

He also outlined key technological methodologies, including acoustic sediment classification using sonar backscatter data, satellite-based monitoring of turbidity and suspended sediment, and predictive modelling with machine learning and hydrodynamic simulations to identify sediment transport patterns and sedimentation hotspots. He further highlighted the practical applications of the framework in assessing infrastructure stability, supporting disaster risk management, monitoring benthic ecosystem health and optimising dredging operations. Case studies from the Karakasa Dam and Ujani Reservoir demonstrated the use of acoustic surveys and remote sensing to validate and monitor sediment accumulation.

Overall, his presentation showcased how integrating advanced technologies with the UDA Framework can support sustainable, science-based sediment management strategies across tropical water systems.

Watch the full video now: https://youtu.be/2r_KaQkWeJc

Rear Admiral YN Jayarathna (Retd), Former Chief Hydrographer, Sri Lanka

The speaker brought a strong operational and regional perspective to the discussion on sediment management. He emphasised the urgent need for an integrated, data-driven approach under the UDA Framework to effectively address sedimentation challenges in tropical waters. He highlighted that sediment management has evolved from a purely scientific or hydrographic concern into a strategic priority, with direct implications for port operations, inland waterways, and the broader blue economy. In this context, he stressed that the dynamic and complex nature of tropical regions demands context-specific solutions, supported by reliable data and modern technologies, rather than one-size-fits-all approaches.

Rear Admiral Jayarathna also underscored the importance of leveraging sediment as a resource for national development. Based on his conversation during the webinar and his reflections and observations, he authored a media article in 'The Morning,' in which he noted that effective sediment and water-body management is critical to unlocking the full potential of water systems. This includes enabling economic growth, supporting livelihoods, and enhancing the sustainable utilization of aquatic resources. Overall, his remarks reinforced the importance of aligning scientific understanding, technological capabilities, and policy directions to build a resilient and forward-looking sediment management strategy for the region.

Watch the full video now: <https://youtu.be/IM8VOVfKEb4>

Dr Amit Rajan, Research Fellow, Institute of South Asian Studies, NUS Singapore

The discussion session following our Research Fellow Romit Kaware's presentation on UDA-based Sediment Management offered an academic critique of the research approach and highlighted the broader governance and policy challenges associated with sediment management in climate-sensitive and transboundary environments. The expert approached the comprehensive scope of the presentation but suggested that a more focused case-study approach- centred on a specific river system, port, or coastal region would strengthen the academic rigour and practical applicability of the findings. A significant part of the discussion focused on the political and governance dimensions of sediment management, particularly in transboundary river systems involving neighbouring countries.

The speaker further noted that sedimentation issues are often linked to disputes over dam operations, dredging practices, water sharing, and infrastructure development. He noted that the absence of reliable, transparent data in these spheres can intensify geopolitical tensions and complicate bilateral cooperation. The session also emphasised the importance of adopting an interdisciplinary framework for addressing sedimentation and climate-related maritime challenges. The speaker highlighted the need to integrate advanced technical tools, such as

sonar systems, acoustic seabed classification, AI-driven modelling, and hydrographic datasets, with insights from political science and social science. Such integration, the speaker noted, is essential not only for improving scientific understanding and predictive capabilities but also for managing interstate negotiations, which will resolve conflicts and address the socio-economic concerns of communities affected by large-scale infrastructure and environmental changes.

Overall, the discussion reinforced the view that sustainable sediment management requires a balanced combination of scientific innovation, policy coordination, regional cooperation, and community-sensitive governance within the broader UDA Framework.

Watch the full video now: <https://www.youtube.com/watch?v=YCKWgpENdtg>

Dr R Chandrashekhar, a Strategic Analyst

The speaker offered a comprehensive bureaucratic, and policy-oriented perspective on sediment management during the webinar. His remarks underscored the critical need for institutional coherence, strategic data governance, and national-level oversight in managing sediment-related challenges. A key theme of his intervention was the need to “reframe the perception of sediment as a valuable resource.” He highlighted that although sediment is often treated as waste once it reaches the sea, it holds significant ecological and economic value, much like the alluvial deposits that sustain fertile river basins. He further recognised that this value is essential for informed policy and sustainable management. The speaker identified ‘institutional fragmentation’ as a major bottleneck. At present, responsibilities for river sedimentation and deep-sea ocean surveys are distributed across multiple ministries and agencies, resulting in siloed operations and limited coordination. This lack of integration hampers the development of a cohesive sediment management strategy.

He emphasised that sediment management is inherently data-driven and stressed the importance of data as a strategic national asset. He called for robust institutional mechanisms to ensure that data collected by private entities or within the Exclusive Economic Zone (EEZ) is systematically captured, governed, and utilised under national oversight, rather than fragmented or exploited externally. Further, from a policy standpoint, Dr Chandrashekhar advocated establishing a dedicated institutional authority responsible for seabed and sediment management. He further noted that India should proactively leverage its position on global platforms, such as the International Seabed Authority, to promote equitable access to and governance of seabed data.

Highlighting the role of national institutions, he suggested that the Indian Navy is well-positioned to serve as a central authority for collating, managing, and operationalising maritime data, given its existing capabilities and strategic mandate. Overall, his insights reinforced the need for a unified governance framework that integrates policy, technology, and institutional collaboration to enable effective sediment management in the IOR.

Watch the full video now: <https://youtu.be/fdpzN-69uw>

Vice Admiral Adhir Arora (Retd), Former Chief Hydrographer, India

Vice Admiral Adhir Arora (Retd) emphasised the strategic significance of sediment management within the Indo-Pacific region and highlighted the urgent need for an integrated UDA Framework to support maritime governance, infrastructure planning, and sustainable development. Drawing on his extensive operational and hydrographic experience, he underscored the importance of sediment data for ensuring navigational safety, efficient anchoring practices, fisheries operations, and coastal infrastructure development. He further stressed the role of the National Hydrographic Office in collecting and managing hydrographic and seabed data, and advocated for greater inter-ministerial collaboration and data sharing to strengthen Marine Spatial Planning initiatives. According to him, breaking down institutional data silos is essential for managing critical maritime assets such as underwater cables, ports, and renewable energy infrastructure.

The speaker further discussed the economic implications of accurate sediment assessment, particularly in port dredging and navigational depth optimisation, where even marginal improvements can significantly enhance shipping efficiency and trade economics. While acknowledging the growing role of AI and data-driven technologies in sediment analysis, he cautioned that high-risk offshore projects still require scientific validation and ground-truthing to avoid structural failures. Addressing environmental concerns, he noted that poorly planned coastal structures often disrupt natural sediment transport, leading to long-term ecological and navigational challenges.

He concluded by highlighting India's expanding maritime domain and the opportunities it presents for the Blue Economy, tourism, and sustainable island development, stressing that sediment intelligence will be critical for informed underwater decision-making in the future.

Watch the full video now: <https://www.youtube.com/watch?v=AL3he9iYlto>

Concluding Remarks by Amb Anup Mudgal, MRC Strategic

In his concluding remarks, Ambassador Anup Mudgal emphasised the growing importance of UDA and sustainable sediment management in ensuring long-term maritime security and environmental resilience in the Indo-Pacific region. He highlights that the ocean must be understood as a strategic partner, noting that comprehending its complex physical, chemical, and biological processes is essential for preventing ecological and security-related challenges. Ambassador Mudgal spoke about the strong interlinkage between climate stability and global security, warning that disruptions to natural marine systems could pose serious existential risks similar to the environmental degradation already witnessed on land. He further stressed that sustainable development initiatives must align with the laws of nature rather than work against them.

He further discussed the significance of integrated, data-driven approaches in maritime and underwater governance, particularly the need to bridge institutional and sectoral data silos. In this regard, he acknowledged the efforts of MRC in developing credible frameworks that can support informed decision-making, conflict resolution, and sustainable economic activities across underwater domains. Referring to the research led by Romit, Ambassador Mudgal noted

that sediment management, though often perceived as a niche subject, has far-reaching implications for port operations, inland waterways, coastal infrastructure, biodiversity conservation, and maritime logistics. He concluded by emphasising the need to consolidate diverse datasets into a comprehensive UDA Framework to support sustainable growth, regional cooperation, and strategic maritime planning in the Indo-Pacific.

Watch the full video now: <https://www.youtube.com/watch?v=gOWbS7sHpbo>

Conclusion

The webinar successfully highlighted the growing importance of sediment management as a critical component for underwater and maritime governance, environmental sustainability, and strategic planning within the Indo-Pacific region. Through insightful discussions by experts, the webinar demonstrated that sediment dynamics are intrinsically linked to navigational safety, coastal infrastructure, port efficiency, ecological balance, and the broader Blue Economy framework. The discussions emphasised the importance of the UDA Framework in enabling integrated, data-driven decision-making by bringing together hydrographic intelligence, scientific research, technological innovation, and policy coordination. The need for interdisciplinary collaboration emerged as a central theme throughout the webinar.

The experts also noted that sustainable maritime development cannot be achieved without credible data sharing, regional cooperation, rigorous scientific validation, and sensitivity to natural environmental processes. In the context of climate change, expanding maritime infrastructure, and increasing geopolitical complexities in the Indo-Pacific, the ability to effectively monitor and manage sediment dynamics will play a crucial role in ensuring long-term maritime resilience and security. Overall, the webinar provided a valuable platform for advancing dialogue on sustainable sediment management and reaffirmed the importance of collaborative frameworks such as UDA in supporting India's blue economy vision, regional stability and sustainable ocean governance.

Image Gallery





