MARITIME RESEARCH CENTER
FOUNDATION FOR UNDERWATER DOMAIN AWARENESS

भारतीय वैश्विक परिषद
Indian Council of World Affairs

MARITIME RESEARCH CENTER (MRC), PUNE
in collaboration with
INDIAN COUNCIL OF WORLD AFFAIRS (ICWA), NEW DELHI

CONCEPT NOTE

Advancing Underwater Domain Awareness (UDA) Framework for India's MAHASAGAR Vision and its Realization

A National Seminar
August 17–18, 2026
Sumant Moolgaokar Auditorium,
MCCIA Trade Tower, Pune - 411016

1.1 Introduction

The underwater domain remains one of the least understood frontiers of the modern era. The strategic decisions made in this space over the coming decade will directly propel the Blue Economy, reinvigorate national infrastructure resilience, inform resource planning, and determine sustainable co-existence between human activity and marine ecosystems. Positioned at a critical geopolitical and technological juncture, the world faces both unprecedented sub-surface volatility and vast strategic opportunities. This national seminar provides a dedicated platform to examine the complex security, economic, and scientific dynamics of our oceans; domains we are only beginning to comprehensively decode.

India's maritime doctrine has progressively evolved from SAGAR (Security and Growth for All in the Region) to the MAHASAGAR vision (Mutual and Holistic Advancement for Security and Growth Across Regions). MAHASAGAR projects India's strategic, economic, and technological leadership across the broader Indian Ocean Region (IOR) and the Global South. However, realizing this ambitious vision requires bridging a fundamental operational gap: Underwater Domain Awareness (UDA). The sub-surface environment—encompassing acoustic tracking, seabed infrastructure protection (such as submarine communication cables), marine biodiversity preservation, port noise management, and sustainable blue economy monitoring; remains heavily under-monitored in the absence of a unified, multidisciplinary framework.

Jointly organized by the Maritime Research Center (MRC), Pune, and the Indian Council of World Affairs (ICWA), New Delhi, this two-day national seminar brings together policy strategists, defense leadership, economists, marine scientists, and research fellows. The dialogue aims to align technical research in underwater acoustics and marine science with high-level geopolitics and national security strategy.

1.2 Objectives

- **Strategic Alignment:** Map the MRC UDA framework directly onto the key pillars of India's MAHASAGAR vision.
- **Stakeholder Convergence:** Foster dialogue across the four core UDA pillars: Maritime Security, Blue Economy, Marine Environment/Disaster Management, and Science & Technology (Research & Innovation).
- **Capacity Building:** Highlight career paths, academic fellowships, and skilling avenues for the next generation of ocean policy leaders and underwater technologists.
- **Policy Deliverables:** Synthesize actionable policy recommendations for subsea governance, marine biofouling standards, acoustic mapping, and blue accounting frameworks.

Dates: August 17–18, 2026

Venue: Sumant Moolgaokar Auditorium, MCCIA Trade Tower, Pune - 411016

Seminar Programme Schedule

Day 1: Strategic Foundations of UDA (August 17)

Time	Session & Topic	Panelists / Key Speakers
9:30 – 9:45	*Welcome Address*	Dr. (Cdr) Arnab Das, *Founder & Director, MRC*
9:45 – 10:00	*Opening Remarks*	Sh. Abhijit Chakraborty, *Joint Secretary - ICWA*
10:00– 11:30	**Session 1:** Evolution of UDA Framework & Global Relevance	**Main Presenter:** Dr. (Cdr) Arnab Das *(Founder & Director, MRC);* **Session Chair:** Admiral Karambir Singh PVSM, AVSM, IN (Retd.) - *Former Chief of Naval Staff*
11:30 – 12:00	**High Tea**	
12:00 – 13:30	**Session 2:** Building the Blue Sun - UDA and its Place in an Evolving World Order	**Main Presenter:** Mr. Callistine Lewis, *Head of Publications, MRC* **Session Chair:** Amb. Anup Mudgal (Retd.) - *Former Indian Diplomat & Member of the Blue Economy Task Force at FICCI, India*
13:30 – 14:30	**Lunch Break**	
14:30 – 16:00	**Session 3:** Modelling & Simulation based Maritime Spatial Planning (MSP)	**Main Presenter:** Mr. Shridhar Prabhuraman, *Deputy Director, MRC* **Session Chair:** Mr. Aditya Kumar Sinha, *Executive Director, CDAC Mumbai*
16:00 – 16:15	**Evening Tea**	
16:15 – 17:30	**Session 4:** Career Opportunities, Skilling & Capacity Building in UDA	**Main Presenter:** Mr. Callistine Lewis; *Head of Publications, MRC* **Session Chair:** Hrishikesh Dhande , *Deputy Director, Pune International Center*

Day 2: Blue Economy, Ecology & Sustainability (August 18)

Time	Session & Topic	Panelists / Key Speakers
9:30 – 9:40	*Opening Remarks*	Gen. Manoj Pande PVSM AVSM VSM (Retd) - *Former Chief of Army Staff of the Indian Army (TBC)*
9:40 – 11:10	**Session 5**: Sediment Management & Navigational Safety	**Main Presenter:** Mr. Romit Kaware, *Research Fellow, MRC* **Session Chair:** Lieutenant General AK Ramesh SM, Commandant *of the College of Military Engineering, Pune (TBC)*
11:10 – 11:40	**Tea Break**	
11:40 – 13:10	**Session 6:** Blue Accounting & Marine Environmental Economics	**Main Presenter:** Mrs. Catherine J, *Head of Research, MRC* **Session Chair:** Dr. Ajit Ranade , *Economist and Former Vice-Chancellor of Gokhale Institute of Politics and Economics, Pune*
13:10 – 14:10	**Lunch Break**	
14:10 – 15:40	**Session 7**: Biofouling, Anthropogenic Noise & Ecological Resilience	**Main Presenter:** Mr. Suchir Mamidala, *Research Fellow, MRC* **Session Chair:** Dr. Kishore M. Paknikar, *Anusandhan National Research Foundation – ANRF Prime Minister Professor*
15:40 – 15:55	**Evening Tea**	
15:55 – 17:25	**Session 8:** Sustainable Fisheries, Aquaculture & Marine Bioresources	**Main Presenter:** Mr. Ashwani Singh, *Research Fellow, MRC* **Session Chair:** Mr. Rakesh Kumar, *General Manager, Bharat Electronics Limited*
17:25 – 17:40	*Workshop Report*	Dr. (Cdr) Arnab Das, Mr. Callistine Lewis
17:40 – 17:45	*Closing Remarks*	Sh. Abhijit Chakraborty, *Joint Secretary - ICWA*

2. Theoretical & Strategic Foundations

2.1 From SAGAR to MAHASAGAR

SAGAR, articulated in 2015, framed India's maritime engagement primarily around security cooperation and capacity-building with immediate IOR neighbours. MAHASAGAR broadens this framing along two axes: it extends India's ambit of engagement across the wider Indian Ocean Region and into the Global South more generally, and it recasts India's role from a regional security partner into a holistic development, governance, and technology partner. This shift is deliberate — it responds to a Global South increasingly wary of great-power competition and looking instead for partners who can offer capacity rather than dependency.

This broader diplomatic ambition creates an operational requirement that has so far gone under-examined: subsurface visibility. Diplomatic commitments to maritime security, disaster resilience, and sustainable blue economy growth are difficult to substantiate without the underlying capability to see, track, and understand what is happening beneath the surface of the ocean India seeks to help govern. A vision built on holistic maritime leadership cannot rest on a surface-only picture of the maritime domain. Underwater Domain Awareness is, in this sense, not a niche technical add-on to MAHASAGAR but a precondition for its credibility.

2.2 The Four Pillars of the UDA Framework

- **Maritime Security:** acoustic tracking, subsea asset protection, and anti-submarine warfare (ASW) advantages.
- **Blue Economy:** resource exploration, deep-sea mining, sustainable energy, and marine spatial planning.
- **Environment & Disaster Management:** seismic monitoring, tsunami early warning, the impact of climate change on acoustic propagation, and biodiversity preservation.
- **Science & Technology:** indigenous hardware and software, acoustic modelling, skilling, and R&D infrastructure.

These four pillars are treated throughout this seminar not as independent silos but as mutually reinforcing dimensions of a single UDA capability. A hydrophone array built for anti-submarine warfare, for instance, generates data equally useful for tsunami early warning and biodiversity monitoring; an acoustic model built for naval sonar prediction underpins both ASW planning and sustainable dredging schedules. The seminar's eight sessions are each mapped explicitly against all four pillars precisely to surface these cross-cutting synergies rather than treat them as coincidental.

2.3 The Rationale for the Seminar

The single greatest obstacle to a coherent national UDA capability is institutional, not technical. The Indian Navy and Coast Guard, marine-science academia, defense and commercial industry (dredging, offshore energy, shipbuilding), and policy think tanks each hold a piece of the UDA puzzle. Naval hydrographic data, university acoustic research, industry operational experience, and foreign policy strategies each develop separate tracks, with few structured mechanisms for cross-pollination.

Each session pairs a technical research fellow with a senior policy, defence, or industry figure as chair or co-panellist, allowing technical material to be translated into policy language in real time, and allowing policy assumptions to be tested against technical reality. The seminar's outputs, draft frameworks, policy briefs, and proposed working groups, are designed to be able to be submitted to national security and foreign-policy institutions, rather than as an academic proceedings volume alone.

Day 1: MRC-ICWA National Seminar on Underwater Domain Awareness

Day 1 · August 17, 2026 · 10:00 AM – 11:30 AM

Session 1: Evolution of the UDA Framework & Global Relevance

Main Presenter: Dr. (Cdr) Arnab Das, *Founder and Director, MRC* ·

Session Chair: Admiral Karambir Singh PVSM, AVSM, IN (Retd.) - *Former Chief of Naval Staff,*

Session Focus: Global strategic relevance of underwater acoustic monitoring and cross-border maritime situational awareness.

1. Context & Problem Statement

India's traditional maritime security and ocean policy frameworks have historically operated under a surface-centric paradigm. While the SAGAR doctrine and its evolved iteration, MAHASAGAR, establish a clear diplomatic and strategic vision for leadership in the Indian Ocean Region (IOR), they face a critical operational limitation at the subsurface level: the UDA blind spot.

The underwater environment of the Indian Ocean presents unique challenges that distinguish it from temperate, deep-water ocean domains where legacy underwater acoustic frameworks were developed. Tropical water dynamics — warm temperatures, variable salinity profiles, high ambient biological noise, and complex bathymetry — severely distort acoustic signal propagation, rendering standard Western sonar models inaccurate when applied without modification to the IOR. Shallow, sediment-heavy littorals fed by monsoon river systems alter seabed absorption characteristics, complicating acoustic tracking, bathymetric mapping, and subsea asset protection.

Compounding this technical gap is a governance gap: maritime security (Navy/Coast Guard), economic exploitation (dredging, offshore energy), environmental monitoring (marine biology), and science and technology (indigenous R&D) currently operate in institutional silos, without a unified data-sharing architecture. To translate the MAHASAGAR vision into tangible regional leadership, India requires a standardized, indigenous UDA framework. Session 1 establishes the theoretical foundation, scientific rationale, and global strategic necessity of UDA as a prerequisite for holistic ocean governance as well as how the global evolution of UDA technology and analysis frameworks have been developed. It will also interrogate the pitfalls and obstacles that India, as a member of the Global South, will need to take note of while charting its own course on the world's waters.

2. Core Themes & Sub-Topics for Deliberation

A. Unique Environmental Dynamics — Tropical vs. Temperate Waters

- Physics of Tropical Sound Propagation: Analyzing high acoustic attenuation, extreme SSP variability, and monsoon-driven stratification in the IOR.
- Overcoming Acoustic Blind Spots: Mitigating high biological ambient noise and sediment absorption that degrade imported sonar performance.
- Indigenous Algorithm Modeling: Developing localized acoustic propagation software tailored to shallow-water tropical littorals to ensure technological independence.

B. Transitioning from "Products" to "Solution-Driven" Architectures

- Data Fusion over Capital Hardware: Moving away from reliance on expensive standalone hardware toward integrated sensor networks, AUVs, gliders, Distributed Acoustic Sensing (DAS), and AI-driven data modeling.
- Democratized Digital Tools: Applying low-capital, data-driven frameworks—exemplified by MRC's Area–Production–Yield (APY) Tool for aquaculture and INCOIS's Potential Fishing Zone (PFZ) advisories—to maximize socioeconomic impact with minimal hardware investment.
- Data Interoperability: Establishing standardized subsea data formats across littoral agencies to resolve information fragmentation.

C. Bridging Strategic Security and the Greater Public Good (3D "Volumetric" Governance)

- Extending MDA Beneath the Surface: Expanding traditional, 2D surface-centric Maritime Domain Awareness into 3D vertical ocean space.
- Critical Maritime Infrastructure Protection (CMIP): Safeguarding submarine communication cables, offshore platforms, and subsea pipelines against gray-zone threats, anchor damage, and sabotage.
- Dual-Use Sensor Infrastructure: Utilising passive acoustic monitoring (PAM) networks simultaneously for Anti-Submarine Warfare (ASW), tsunami early warning, and marine biodiversity mapping.

D. Overlaying Traditional Ecological Knowledge (TEK) with Modern Science & AI

- Integrating Local Knowledge: Leveraging the generational ecological observations of coastal and fishing communities as empirical data streams for formal scientific research.
- AI & Big Data Analytics: Fusing TEK with oceanographic buoy data, satellite observations, and hydrophone inputs using AI models to validate ecosystem shifts, fish aggregation, and illegal activities.
- Participatory Ocean Governance: Positioning coastal communities as active contributors to national underwater situational awareness rather than passive observers.

E. Addressing Global South Priorities & Technological Independence

- Closing the Global North–South Capability Gap: Reducing reliance on foreign proprietary oceanographic software and imported hardware built for temperate zones.
- Sovereign Oceanographic Databases: Building regional, tropical-specific ocean databases across Indian Ocean littoral states to foster scientific independence.
- Extending Coalition Logic (Quad/IPMDA): Building on surface frameworks like the Quad's *Indo-Pacific Partnership for Maritime Domain Awareness (IPMDA)* to create subsurface data-sharing mechanisms for small island developing states (SIDS) and LDCs in the IOR.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Subsurface threat detection & Anti-Submarine Warfare (ASW)	Enhancing sonar detection ranges; identifying non-cooperative subsea vessels in tropical waters.
Blue Economy	Safe navigation & subsea resource exploration	Providing accurate acoustic bathymetry for offshore platform installation and deep-sea mineral exploration.
Disaster & Environment	Seismic activity & marine ecosystem monitoring	Utilizing passive acoustic monitoring (PAM) for tsunami early warnings and mapping marine biodiversity soundscapes.
Science & Technology	Indigenous hardware & acoustic software modelling	Reducing dependence on imported oceanographic software by developing indigenous tropical acoustic models.

Day 1 · August 17, 2026 · 12:00 PM – 1:30 PM

Session 2: Building the Blue Sun: UDA and its Place in an Evolving World Order

Main Presenter: Mr. Callistine Lewis, *Head of Publications, Research Fellow, MRC*

Session Chair: Amb. Anup Mudgal (Retd.) - *Former Indian Diplomat & Member of the Blue Economy Task Force at FICCI, India*,

Session Focus: Geopolitical shifts in the IOR, subsea cable vulnerabilities, seabed governance, and India's role in Global South security architecture.

1. Context & Problem Statement

The ocean dictates the structural foundation of planetary life and human civilisation: covering 71% of the Earth's surface, it governs biodiversity, food security, climate regulation, global trade, internet communications, international finance, cultures, livelihoods, and statecraft. Yet, as the global balance of power undergoes a historical realignment, traditional statecraft remains constrained by a land-centric, Westphalian bias. India's MAHASAGAR doctrine offers a transformative framework for the Global South, expanding India's maritime posture from regional security partner to a global leader in holistic ocean governance, trade, and technology sharing. However, operationalising MAHASAGAR across the Indian Ocean Region (IOR) and beyond requires confronting five interconnected world order dimensions. Firstly, Ocean geopolitics forms the bedrock of the modern world order. Yet, Westphalian concepts of rigid terrestrial borders dissolve at sea, where control over subsea cables, maritime choke points, and subsurface resources dictates strategic supremacy. While traditional Westphalian sovereignty relies on two-dimensional land maps; effectively reading only the floor and ceiling of a room: it leaves our vast, three-dimensional maritime territorial space entirely invisible, obscuring the critical water column where modern geopolitical, economic, and ecological realities unfold.

Secondly, over 80% of global trade by volume travels by sea, and international financial systems rely entirely on underwater data cables, making the sub-surface the ultimate backbone of global supply chains and economic stability. Thirdly, ecological collapse is an existential threat to world order; while marine spaces have suffered severe exploitation, they possess rapid regenerative capacity: acting as the planet's vital "lungs" and carbon reserves. Fourth, with over 50% of humanity or 4.15 billion people living within 100 miles of a coast and rapid demographic expansion across South Asia and Africa, the geopolitical center of gravity is shifting toward the Indian Ocean, projected to host over 3.9 billion people or 40% of global population by 2050. And finally, power projection rests on technological capability, yet current sub-surface technology, developed in the Global North for cooler, calmer, shallower waters, faces severe degradation when deployed in the warmer, deeper, acoustically complex, and biologically dense tropical waters of the Global South.

Realizing the MAHASAGAR vision requires moving beyond surface-level presence. Underwater Domain Awareness (UDA) provides the operational backbone for this doctrine, converting raw sub-surface data into strategic clarity, sustainable blue growth, and inclusive global governance.

2. Core Themes & Sub-Topics for Deliberation

A. Politics & Statecraft: Beyond Westphalian Terrestrialism

- Reconceptualizing Maritime Sovereignty: Re-evaluating traditional, land-centric Westphalian governance in fluid, 3D sub-surface spaces where UNCLOS legal ambiguities leave critical subsea infrastructure vulnerable.
- Sub-Surface Geopolitics & Infrastructure Security: Countering grey-zone tactics, unattributed sub-surface activity, and safeguarding submarine fiber-optic cables and seabed energy pipelines across strategic choke points.
- Plurilateral Leadership under MAHASAGAR: Positioning India's UDA framework as an exportable public good, fostering flexible plurilateral security and data-sharing coalitions with Global South littorals and Small Island Developing States (SIDS).

B. Economics & the Blue Economy: Securing Global Financial Arteries

- Safeguarding Commercial Backbones: Protecting the physical and digital sub-surface infrastructure—from oceanic trade routes to subsea internet cables—that anchors international trade, banking, and supply chain resilience.
- MAHASAGAR-Driven Marine Spatial Planning (MSP): Resolving spatial conflicts between offshore energy, deep-sea mining, shipping lanes, and traditional fisheries to ensure long-term economic stability across the Global South.
- Attracting Blue Capital: Creating standardized, transparent sub-surface data architectures that attract global green and blue investment while preventing predatory resource extraction.

C. Environment & Climate Resilience: The Ocean's Diagnostic MRI

- UDA as the Planet's Diagnostic Scanner: Deploying passive acoustic monitoring and sub-surface sensors as a diagnostic "MRI scanner" to assess, monitor, and restore ocean ecosystems, carbon sequestration sinks, and atmospheric oxygen generation.
- Pre-Empting Climate Tipping Points: Tracking rising sub-surface temperatures, ocean acidification, and shifting current dynamics in real time before marine systems cross irreversible tipping points.
- Regenerative Ocean Governance: Capitalizing on the rapid natural regenerative capacity of underwater ecosystems to offset terrestrial environmental degradation under the ecological pillar of MAHASAGAR.

D. Demography & Human Capital: Blue Jobs for Global South Youth

- Absorbing Underutilized Youth Demographics: Leveraging the massive youth demographic in India and the Global South to meet expanding labor demands in offshore renewable energy, sustainable aquaculture, bio-conservation, and maritime logistics.
- Empowering Coastal & Marginalized Communities: Transitioning coastal youth from vulnerable, declining traditional fishing toward high-value "green and blue" sectors through UDA-linked technical skilling.
- Social Stability & Regional Security: Mitigating youth discontent, illegal migration, and maritime piracy by generating sustainable, ocean-derived economic opportunities along tropical coastlines.

E. Technology & Sovereignty: Tailoring Innovation to Tropical Waters

- Overcoming Northern Technological Bias: Moving away from imported oceanographic hardware built for cold, shallow northern waters, and developing indigenous algorithms optimized for warm, acoustically complex, and biologically dense tropical oceans.
- Solution-Driven Architecture over Hardware Accumulation: Shifting from capital-intensive standalone hardware toward integrated, data-driven frameworks—aligning indigenous R&D (such as India's Deep Ocean Mission) with MAHASAGAR's capacity-building goals.

- Bridging the Global North–South Capability Gap: Fostering technological self-reliance (Atmanirbhar Bharat) while sharing accessible, low-cost digital tools and sub-surface platforms with regional partners.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Sub-surface asset protection, choke-point vigilance, and non-Westphalian plurilateral statecraft under MAHASAGAR.	Real-time acoustic tracking of subsea cables, threat discrimination in high-density corridors, and non-cooperative sub-surface target identification.
Blue Economy	Securing global financial flows, trade routes, and blue job creation for Global South youth.	Risk-informed subsea infrastructure routing, data-driven marine spatial planning, and workforce integration in offshore renewable energy.
Disaster & Environment	Diagnostic monitoring of ocean health, carbon reserves, and climate-induced tipping points.	Deploying passive acoustic monitoring (PAM) networks for ecosystem diagnosis, sub-surface thermal tracking, and early warning systems.
Science & Technology	Developing localized tropical acoustic tools and bridging North–South technological divides.	Indigenous algorithm modeling for high-ambient-noise tropical waters and accessible digital tool deployment under the Deep Ocean Mission.

Day 1 · August 17, 2026 · 2:30 PM – 4:00 PM

Session 3: Modelling & Simulation for Maritime Spatial Planning (MSP)

Main Presenter: Mr. Shridhar Prabhuraman, *Deputy Director, MRC* ·

Session Chair: Mr. Aditya Kumar Sinha, *Executive Director, CDAC Mumbai*

Session Focus: Marine Spatial Planning, Acoustic propagation modelling, underwater digital twins, and simulation tools supporting sustainable ocean governance.

1. Context & Problem Statement

India's coastal and Exclusive Economic Zone (EEZ) waters are governed today largely through static, two-dimensional maps that struggle to represent a dynamic, multi-user underwater environment. Naval exercises, commercial shipping lanes, fishing grounds, offshore energy leases, and marine protected areas (MPAs) increasingly compete for the same subsurface and water-column space, and static planning tools cannot resolve these conflicts efficiently or safely.

The emerging alternative is the underwater digital twin: a continuously updated, multi-layered digital representation of bathymetry, acoustic conditions, currents, and biodiversity that allows planners to simulate outcomes before committing resources on the water. Acoustic propagation modelling — predicting sonar detection ranges and mapping underwater noise footprints under tropical sound-speed conditions — forms the technical backbone of such a twin and must be validated against field data gathered specifically in Indian coastal waters rather than imported wholesale from temperate-water models.

Building this capability at national scale requires resolving an institutional question as much as a technical one: which agency owns, updates, and shares digital-twin data across the Navy, the Ministry of Earth Sciences' agencies (INCOIS, NIOT), state maritime boards, and industry users. Session 3 sets out both the technical case for underwater digital twins and a proposed data-governance architecture to sustain them.

2. Core Themes & Sub-Topics for Deliberation

A. Acoustic Propagation Modelling

- Sonar range prediction under variable tropical sound-speed profiles (SSPs).
- Underwater noise mapping across shipping lanes and port approaches.
- Validating models against field data gathered in Indian coastal waters, rather than imported temperate-water datasets.

B. Underwater Digital Twins for MSP

- Multi-layered digital-twin architecture integrating bathymetry, acoustics, currents, and biodiversity data.
- Real-time data assimilation from AUVs, moored buoys, and satellite altimetry.
- Priority use cases: naval-exercise deconfliction, shipping-lane optimization, and MPA design.

C. Institutional Data Architecture

- Common data standards across the Navy, MoES agencies (INCOIS, NIOT), and state maritime boards.
- Data-sharing protocols that balance operational security with planning transparency for industry and researchers.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Deconfliction of naval exercises with commercial and fishing activity	Digital twin overlays of restricted zones and shipping density.
Blue Economy	Efficient marine spatial planning for offshore energy and mining	Simulation-driven site selection reducing conflict and delay.
Disaster & Environment	MPA design informed by acoustic and ecological modelling	Dynamic zoning responsive to seasonal biodiversity patterns.
Science & Technology	Indigenous simulation and digital-twin software	Reduced reliance on imported modelling platforms.

Day 1 · August 17, 2026 · 4:15 PM – 5:30 PM

Session 4: Career Opportunities, Skilling & Capacity Building in UDA

Main Presenter: Mr. Callistine Lewis, *Head of Publications, Research Fellow, Maritime Research Center* ·
Session Chair: Hrishikesh Dhande , *Deputy Director, Pune International Center*
Session Focus: Bridging academia, defense, and industry to build indigenous talent in underwater technology and ocean policy.

1. Context & Problem Statement

Every technical and policy ambition articulated across this seminar rests on a scarce resource: trained people. India faces a severe deficit of specialised manpower in underwater domain awareness — underwater acousticians, marine signal-processing engineers, and subsea policy analysts capable of translating acoustic data into strategic judgment. This shortage is not confined to the defence establishment; think tanks, ports, and industry face the same gap in different forms.

Part of the problem is structural: STEM curricula in Indian universities rarely include applied ocean-technology content, and international-relations or public-policy programmes rarely engage with the physical realities of the subsurface domain. The result is two parallel talent pipelines — technical and policy — that almost never intersect, producing acoustics graduates unable to communicate with strategists, and strategists unable to interrogate the technical assumptions behind the advice they receive.

Closing this gap requires a deliberate triple-helix model connecting academia, defence R&D (DRDO, the Navy), and indigenous industry, supported by structured fellowship pathways, youth engagement, and vocational training for coastal communities. Session 4 sets out a concrete proposal for building this pipeline, drawing on MRC's own experience running research fellowships that combine technical and policy training.

2. Core Themes & Sub-Topics for Deliberation

A. The Talent Deficit

- Shortage of underwater acousticians, marine signal-processing engineers, and subsea policy analysts.
- Mismatch between STEM curricula and applied ocean-technology needs.
- Absence of dedicated subsea-policy career tracks within civil services and think tanks.

B. Curriculum and Institutional Integration

- Embedding UDA modules into marine science, engineering, and international-relations programmes.
- Joint fellowships linking think tanks and university departments.
- Vocational and skilling pathways for coastal youth in acoustic monitoring and ROV/AUV operation.

C. Triple-Helix Collaboration

- Structured internship and secondment pipelines spanning the Navy/DRDO, academia, and industry.
- Industry-sponsored research chairs and innovation challenges.
- Mentorship networks connect early-career researchers to policy practitioners.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Building a pipeline of trained acoustic and ASW analysts	Naval–academic exchange and secondment programmes.
Blue Economy	Skilled workforce for offshore, dredging, and energy sectors	Industry-linked vocational certification.
Disaster & Environment	Field-ready personnel for monitoring networks	Community-based training in coastal early-warning systems.
Science & Technology	Sustained indigenous R&D talent pipeline	Fellowship-to-employment pathways in defense and industry R&D.

Day 2: MRC-ICWA National Seminar on Underwater Domain Awareness

Day 2 · August 18, 2026 · 9:40 AM – 11:10 AM

Session 5: Sediment Management & Navigational Safety

Main Presenter: Mr. Romit Kaware, *Research Fellow, Maritime Research Center*

Session Chair: Lieutenant General AK Ramesh SM, *Commandant of the College of Military Engineering, Pune,* Session Chair

Session Focus: Acoustic techniques for sediment profiling, sustainable dredging policy, and dual-use navigational readiness.

1. Context & Problem Statement

India's tropical rivers, estuaries and coastal zones face some of the highest siltation rates in the world, driven by monsoon-fed systems that deposit heavy sediment loads at the coast. Left unmanaged, this siltation reduces navigational draft limits, constrains naval channel mobility, and forces increasingly frequent and costly dredging campaigns — a problem set to intensify as Sagarmala-driven port expansion adds capacity along India's coastline.

Acoustic sediment monitor and quantification offers a path toward predictive rather than reactive management: real-time bathymetric and sub-bottom profiling can track shifting sediment loads through the tropical conditions and monsoon cycle and informed dredging schedules before channels become operationally constrained. But dredging itself carries ecological cost — it's not a long term solution. Disturbance to the seabed/riverbed and resulting sediment redistribution negatively impact fish spawning grounds and mangrove ecosystems. The current regulatory processes often treat Sagarmala expansion targets and environmental clearance regimes as separate, sequential hurdles rather than a jointly optimized system.

There is also an underexploited dual-use opportunity: commercial ports and adjacent naval facilities frequently share the same estuarine system yet rarely share sediment-monitoring infrastructure or data. The lack of a data sharing platform hampers the comprehensive understanding of local dynamics. Session 5 makes the case for acoustic sediment monitoring as shared infrastructure serving navigational safety, port efficiency, and ecological stewardship simultaneously.

2. Core Themes & Sub-Topics for Deliberation

A. Acoustic Sediment Profiling

- Real-time bathymetric and sub-bottom profiling techniques suited to tropical estuarine conditions.
- Tracking shifting sediment loads through the monsoon cycle in real time.
- Integrating profiling data with port dredging schedules and naval channel maintenance planning.

B. Applications of Sediment Management

- Optimising dredging frequency and sediment-removal volumes while minimising disruption to estuarine and coastal ecosystems.
- Assessing and mitigating the acoustic, turbidity, and water-quality impacts of dredging on fish-spawning grounds, mangroves, and other sensitive habitats.
- Supporting beneficial reuse of dredged sediment for beach nourishment, land reclamation, wetland restoration, and shoreline protection.

- Integrating sediment-management requirements with port expansion, navigational safety, environmental clearance procedures, and long-term coastal resilience planning.

C. Digital Transformation in Sediment Management

- Establishing real-time sediment-monitoring systems using acoustic sensors, turbidity meters, satellite observations, and autonomous survey platforms.
- Developing digital twins of ports, estuaries, and navigation channels to predict sediment transport, shoaling, and future dredging requirements.
- Applying artificial intelligence and data analytics to optimise dredging schedules, reduce operational costs, and minimise environmental impacts.
- Creating interoperable data-sharing platforms across ports, environmental agencies, research institutions, and maritime-security organisations.
- Implementing automated decision-support systems for navigational safety, dredging prioritisation, environmental compliance, and emergency response.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Assured channel depth for naval mobility	Shared sediment-monitoring data with Navy hydrographic units.
Blue Economy	Port efficiency and reduced dredging costs	Predictive dredging schedules based on acoustic profiling.
Disaster & Environment	Minimizing ecological disruption from dredging	Environmental-impact-informed dredging windows.
Science & Technology	Indigenous sediment-profiling instrumentation	Reduced dependence on imported survey equipment.

Day 2 · August 18, 2026 · 11:40 AM – 1:10 PM

Session 6: Blue Accounting & Marine Environmental Economics

Main Presenter: Mrs. Catherine J, Head of Research, MRC ·

Session Chair: Dr. Ajit Ranade , *Economist and Former Vice-Chancellor of Gokhale Institute of Politics and Economics, Pune*

Session Focus: Integrating Blue Accounting, ocean-resource valuation, and marine environmental economics into national policy.

1. Context & Problem Statement

Conventional GDP accounting is structurally blind to ocean degradation. It records the revenue from a fishery, a dredged port channel, or an offshore energy lease, but not the depletion of the natural capital that generated that revenue, nor the depreciation of subsea infrastructure, nor the loss of coastal ecosystem services such as storm buffering and carbon sequestration. As India's blue economy ambitions scale up under MAHASAGAR, this blind spot risks systematically overstating the sustainability of ocean-based growth.

Blue Accounting offers a corrective: methodologies for valuing marine natural capital — coastal wetlands, mangroves, deep-sea ecosystems — alongside more conventional economic output, drawing on international precedents such as the UN System of Environmental-Economic Accounting (SEEA) and its ocean-specific extensions. Embedding these methodologies into India's System of National Accounts (SNA) would require sustained coordination between the Ministry of Earth Sciences, NITI Aayog, and the Ministry of Statistics and Programme Implementation, alongside sector-specific ESG metrics tailored to maritime, port, and shipping industries.

Valuation alone does not finance conservation. Blue bonds, blended-finance instruments, and carbon-credit frameworks for blue-carbon ecosystems (mangroves, seagrass) offer mechanisms to convert natural-capital accounting into investable projects, provided risk-sharing structures can de-risk private capital sufficiently to participate at scale. Session 6 lays out both the accounting and financing sides of this agenda.

2. Core Themes & Sub-Topics for Deliberation

A. Valuing Marine Natural Capital

- Methodologies for valuing coastal wetlands, mangroves, and deep-sea ecosystems.
- Accounting for subsea asset depreciation — cables, pipelines, and other seabed infrastructure.
- International precedents, including UN SEEA and related ocean natural-capital accounting frameworks.

B. Integrating Blue Accounting into National Planning

- Pathways to incorporate ocean-asset accounts into India's System of National Accounts (SNA).
- ESG metrics tailored specifically to maritime, port, and shipping industries.
- Coordination requirements across the Ministry of Earth Sciences, NITI Aayog, and the Ministry of Statistics.

C. Financing Ocean Conservation

- Blue bonds and blended-finance instruments for coastal restoration.
- Carbon-credit frameworks for blue-carbon ecosystems such as mangroves and seagrass.
- Risk-sharing models to de-risk private investment in ocean conservation.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Economic case for protecting strategic coastal and subsea assets	Valuation data informing infrastructure protection budgets.
Blue Economy	Investment-grade metrics for sustainable ocean industries	ESG-linked financing for ports, shipping, and offshore sectors.
Disaster & Environment	Quantifying the cost of ecosystem loss from disasters	Blue-carbon accounting tied to restoration financing.
Science & Technology	Data infrastructure for natural-capital accounting	Indigenous monitoring networks feeding national accounts.

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Session 7: Biofouling, Anthropogenic Noise & Ecological Resilience

Main Presenter: Mr. Suchir Mamidala, Research Fellow, MRC

Session Chair: Dr. Kishore M. Paknikar, *Anusandhan National Research Foundation– ANRF Prime Minister Professor*

Session Focus: Managing underwater noise pollution, biofouling management, and port ecosystem health in line with global IMO benchmarks.

1. Context & Problem Statement

Shipping traffic and port operations generate two underappreciated but serious environmental pressures: underwater noise pollution and biofouling-driven invasive species transfer. Rising vessel traffic along India's coast, concentrated around a small number of major ports, is pushing ambient underwater noise levels upward in exactly the shallow, biologically rich waters least equipped to absorb them, even as the International Maritime Organization (IMO) has moved toward voluntary guidelines on ship-radiated noise reduction. Biofouling presents a parallel dilemma. Hull fouling increases drag and fuel consumption, creating a commercial incentive for aggressive anti-fouling coatings — but many of the most effective coatings are also toxic to marine ecosystems, while biofouled hulls themselves are a leading vector for invasive marine species entering Indian port waters from international shipping routes. Balancing hull efficiency, fuel economy, and ecological safety requires both better data and better technology, not a simple trade-off between economics and the environment. Long-term monitoring of port-adjacent ecological zones — tracking biodiversity health alongside noise and biofouling indicators — is the missing feedback loop that would let ports, shipping lines, and regulators calibrate standards against real outcomes rather than assumptions. Session 7 calls for tying underwater noise, biofouling, and ecosystem resilience into a single, IMO-aligned management agenda, with direct industry participation.

2. Core Themes & Sub-Topics for Deliberation

A. Managing Underwater Noise Pollution

- Alignment with IMO guidelines on reducing underwater radiated noise from commercial shipping.
- Noise budgeting for high-traffic port approaches and shipping lanes.
- Acoustic monitoring as a compliance and enforcement tool.

B. Biofouling Management

- Trade-offs between hull efficiency, fuel burn, and toxic anti-fouling coatings.
- Invasive-species transfer risk via biofouling at Indian ports.
- Emerging non-toxic and inspection-based biofouling management technologies.

C. Port Ecosystem Health Monitoring

- Long-term monitoring of sensitive ecological zones near major ports.
- Integrating biofouling and noise data into port environmental management plans.
- Industry engagement in setting ecological resilience standards.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Naval vessel biofouling and noise-signature management	Standards reducing acoustic detectability and hull drag.
Blue Economy	Port competitiveness through environmental compliance	IMO-aligned standards attracting green shipping traffic.
Disaster & Environment	Ecosystem health monitoring near ports	Long-term biodiversity monitoring frameworks
Science & Technology	Indigenous biofouling-resistant coatings and noise-reduction technology	R&D partnerships with industry.

Day 2 · August 18, 2026 · 3:55PM – 5:25 PM

Session 8: Sustainable Fisheries, Aquaculture & Marine Bioresources

Main Presenter: Mr. Ashwani Singh, Research Fellow, MRC

Session Chair: Mr. Rakesh Kumar, *General Manager, Bharat Electronics Limited*

Session Focus: Acoustic impact on marine fauna, tech-driven sustainable fishing practices, and coastal community empowerment.

1. Context & Problem Statement

Overfishing, climate-driven habitat shift, and largely unmonitored human activity are converging to threaten both coastal livelihoods and national food security along India's coastline. Much of this pressure remains invisible in real time: stock movements, spawning disruption, and illegal, unreported and unregulated (IUU) fishing activity are difficult to detect through conventional surface-based monitoring alone.

Underwater acoustics offer a partial but powerful answer. Passive acoustic monitoring can track the impact of shipping, naval, and industrial noise on fish migration and spawning behaviour, while acoustic and AI-assisted catch-monitoring tools can support far more precise stock assessment than traditional methods. Layering satellite surveillance with UDA sensor networks additionally improves detection of IUU fishing activity within India's EEZ — a capability with both economic and security value.

None of this technology delivers benefit unless it reaches the communities who depend on fisheries for their livelihood. Low-cost, indigenously developed sensors — of the kind C-DAC and similar institutions are positioned to build — combined with structured training programmes, can put subsea monitoring capability directly into the hands of small-scale and traditional fishing communities, linking their catch data into national stock-assessment systems rather than treating them purely as subjects of monitoring. Session 8 sets out this technology-and-livelihood agenda together.

2. Core Themes & Sub-Topics for Deliberation

A. Acoustic Impacts on Marine Fauna

- Effects of shipping, naval, and industrial noise on fish migration and spawning behaviour.
- Passive acoustic monitoring of commercial fish-stock movement.
- Balancing naval sonar use with the protection of sensitive fisheries zones.

B. Technology-Driven Precision Fishing

- AI-assisted catch monitoring and sonar-based stock assessment.
- Satellite–UDA integration for detecting illegal, unreported, and unregulated (IUU) fishing activity.
- Deployment of low-cost, indigenous sensors for small-scale fisheries.

C. Empowering Coastal Communities

- Training traditional fishing communities in the use of subsea monitoring technology.
- Cooperative models linking fisherfolk-generated data to national stock-assessment systems.
- Livelihood diversification through aquaculture and blue-economy skilling.

3. Alignment with the Four Pillars of UDA

UDA Pillar	Strategic Session Focus	Operational Application
Maritime Security	Fisheries surveillance overlapping with IUU and security monitoring	Shared sensor networks serving both stock and security data needs.
Blue Economy	Sustainable fisheries as a blue-economy pillar	Technology-enabled precision fishing raising yields sustainably.
Disaster & Environment	Protecting fish stocks from acoustic and climate stress	Acoustic monitoring informing catch-limit policy.
Science & Technology	Indigenous low-cost sensor and AI monitoring tools	C-DAC and indigenous technology deployment in small-scale fisheries.

4. Annexures & Reference Material

4.1 Glossary

- UDA — Underwater Domain Awareness: the capability to detect, track, and understand activity and conditions within the underwater environment.
- MAHASAGAR — Mutual and Holistic Advancement for Security and Growth Across Regions: the successor doctrine to SAGAR, extending India's maritime engagement across the IOR and Global South.
- MSP — Maritime Spatial Planning: the process of allocating and managing marine space among competing uses (naval, commercial, ecological).
- SSP — Sound Speed Profile: the variation of underwater sound velocity with depth, critical to acoustic propagation modelling.
- PAM — Passive Acoustic Monitoring: the use of underwater microphones (hydrophones) to detect and analyse ambient and biological sounds.
- SCIP — Subsea Critical Infrastructure Protection: policy and operational measures to secure seabed cables, pipelines, and installations.
- Blue Accounting — methodologies for incorporating the value of marine natural capital and ecosystem services into economic accounts.

4.2 Profiles of Collaborating Institutions

Maritime Research Center (MRC), Pune

MRC is a research institution focused on underwater domain awareness, maritime security, and blue economy policy, combining technical research in underwater acoustics and marine science with policy analysis and publications for national and regional audiences.

Indian Council of World Affairs (ICWA), New Delhi

ICWA is India's oldest think tank on international affairs, engaging in research, dialogue, and policy advocacy on foreign policy and international relations, and serves as co-convener and institutional sponsor of this seminar.