UDA Summer Internship 2026

Final Report

Research, Capacity Building and Knowledge Exchange under the Underwater Domain Awareness (UDA) Framework

Maritime Research Center (MRC), Pune

2026

MARITIME RESEARCH CENTER

FOUNDATION FOR UNDERWATER DOMAIN AWARENESS

Prepared as an institutional record of the UDA Summer Internship 2026 programme, student research, mentorship, expert engagement and knowledge dissemination activities

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Executive Summary

The UDA Summer Internship 2026 was conceived as a research-oriented capacity-building initiative to introduce students from leading higher-education institutions to the interdisciplinary challenges of the underwater and maritime domains. Anchored in the Underwater Domain Awareness (UDA) Framework of the Maritime Research Center (MRC), the programme brought together students, researchers, technical mentors and external experts around real-world problems spanning acoustics, marine spatial planning, environmental modelling, sediment management, biofouling, fisheries and climate resilience.

The programme created an environment where students could move beyond classroom learning and work on problem statements with practical relevance to ocean governance, maritime operations, environmental sustainability, and technology development. The available programme documentation records twelve IIT-linked student research projects from IIT Bombay, IIT Delhi, IIT Madras and IIT Kanpur. It further includes research work driven by students from BITS Pilani College and Liberal Arts students from St. Stephen's College, Delhi. Their work ranged from riverine flood modelling and coral bleaching risk assessment to passive sonar, ambient noise, sediment transport, biofouling and artisanal fishing fleet detection. These projects demonstrate the breadth of applications the UDA framework can accommodate.

A significant knowledge-dissemination milestone was the World Oceans Day 2026 showcase, where student researchers presented their work to an audience that included experts from maritime security, academia, publishing, industry, and diplomacy. The showcase reinforced the value of interdisciplinary student research and bridged academic investigation with wider conversations on ocean sustainability and maritime capability.

The internship therefore functioned at three interconnected levels: as a student research programme, as a capacity-building exercise, and as a mechanism for expanding the UDA research ecosystem. It also gave MRC an opportunity to identify emerging talent, test research ideas, strengthen institutional relationships, and build a pipeline of projects that can be further developed through research, technology intervention, or future collaboration.

This report documents the programme's rationale, design, student research portfolio, knowledge-building activities, outcomes, learnings and recommendations. It is intended to serve as both a record of the 2026 cohort and a foundation for strengthening future UDA internship cycles.

At a Glance

Parameter	Summary
Programme	UDA Summer Internship 2026
Institutional anchor	Maritime Research Center (MRC), Pune
Research orientation	Interdisciplinary underwater and maritime research
Institutions represented	IIT Bombay, IIT Delhi, IIT Madras, IIT Kanpur, BITS Pilani and St. Stephen's College
Major research themes	Acoustics; MSP/environmental modelling; sediment management; biofouling; fisheries/aquaculture; climate resilience

Major dissemination milestone	World Oceans Day 2026 student research showcase
Primary outcomes	Research exposure, technical learning, expert interaction, knowledge dissemination and capacity building

1. Introduction

The Underwater Domain is being recognised as an interconnected space where security, economic activity, environmental systems, infrastructure, scientific research and community livelihoods overlap. Understanding this domain requires more than a single disciplinary lens. It requires combining observations from the physical environment with acoustic, geospatial, ecological, engineering, social, and policy perspectives.

MRC has developed the Underwater Domain Awareness (UDA) Framework as a structured approach to understanding and responding to these interconnected challenges. Within this framework, research and technology are complemented by policy intervention, technology intervention and capacity and capability building. The UDA Summer Internship 2026 was designed in this larger institutional context.

The internship gave students opportunities to engage with research problems directly connected to the underwater and maritime environment. The documented portfolio includes work on tropical river basins, coral reefs, passive sonar, ambient noise, freshwater sediment, biofouling, fisheries and subsurface observations. The diversity of these projects reflects an important characteristic of UDA: the underwater domain cannot be treated as a single sector or problem.

The programme also sought to expose students to translating research into communication and stakeholder engagement. Presenting student work through the World Oceans Day 2026 programme and other key webinars gave young researchers an important opportunity to articulate their methods, findings, and relevance to a wider audience.

2. Background

Traditional approaches to Underwater Domain Awareness (UDA) have often focused on the visible, surface-level environment. The underwater domain presents a different set of challenges. Water limits visibility, acoustic propagation varies with environmental conditions, sediment dynamics affect infrastructure and navigation, and ecological systems respond to multiple interacting pressures. At the same time, the underwater environment supports fisheries, coastal livelihoods, critical infrastructure, marine ecosystems and strategic activities.

The UDA approach responds to this complexity by bringing together sensing, analysis, interpretation, decision support and stakeholder engagement. ***MRC's wider work describes the technology intervention through the progression from 'To See' to 'To Understand' and 'To Share': sensing systems generate environmental data; analytics and AI transform data into actionable insight; and those insights are disseminated to stakeholders for informed decision-making.***

The rationale for an internship programme follows directly from this model. A sustainable UDA ecosystem requires a pipeline of researchers and practitioners who understand not only their technical discipline but also how that discipline contributes to a wider maritime system. Students from

engineering, science, liberal arts and allied fields can contribute to specific research problems while developing an appreciation of their broader operational and societal context.

The internship also reflects the growing importance of interdisciplinary collaboration. The World Oceans Day programme and other webinars demonstrating final presentations by our Summer Interns highlighted that student-led research can address real-world underwater challenges and that AI, satellite remote sensing, and acoustic monitoring are increasingly relevant to underwater and maritime research.

2.1 UDA as an Interdisciplinary Framework

The UDA Framework connects maritime security, Blue Economy activities, marine environmental management, disaster resilience and science and technology. This creates space for projects that may initially appear to belong to different disciplines but are linked by a common requirement: the ability to observe, understand and manage underwater systems.

The 2026 internship portfolio illustrates this breadth. A flood module for tropical river basins and a passive sonar classification system use very different methods, yet both contribute to a more informed understanding of aquatic environments. Similarly, coral bleaching modelling, sediment transport analysis, biofouling characterisation and fishing fleet detection address different stakeholders but can be situated within an integrated UDA research ecosystem.

2.2 Need for Young Researchers

Capacity building is central to sustaining research ecosystems. The internship gave students an opportunity to work with research-oriented mentors, understand problem formulation, apply technical methods, and communicate their work. It also created opportunities for students to interact with experts beyond their immediate academic departments.

3. Objectives of the UDA Summer Internship 2026

The UDA Summer Internship 2026 was designed around a set of mutually reinforcing objectives.

1. The first objective was to expose students to contemporary research challenges in the underwater and maritime domains. Rather than limiting the experience to observational learning, the programme sought to place students within active research themes and encourage problem-solving.
2. The second objective was to strengthen interdisciplinary capability. The selected projects brought together concepts from engineering, environmental science, remote sensing, artificial intelligence, acoustics, hydrology, ecology and maritime studies. This enabled students to see how individual technical skills can be applied within broader UDA challenges.
3. The third objective was to build practical research skills. Students were expected to engage with datasets, analytical methods, modelling approaches, technical literature and presentation of results. Where applicable, the projects also encouraged the development of tools, models or analytical workflows that can form the basis for subsequent research.
4. The fourth objective was knowledge exchange. Through lectures, mentoring and the final research showcase, students were exposed to perspectives from MRC researchers and external experts. The programme thus treated communication and discussion as integral parts of research development.

5. The fifth objective was to strengthen the wider UDA ecosystem by linking MRC with leading academic institutions. The internship can be viewed as a platform where academic talent, institutional research priorities, and applied maritime problems intersect.

3.1 Intended Outcomes

- Exposure to real-world underwater and maritime research problems.
- Development of technical and analytical research capabilities.
- Application of interdisciplinary methods to UDA-related challenges.
- Improved ability to communicate research to expert and non-specialist audiences.
- Creation of research outputs that can inform subsequent MRC work.
- Strengthening of academic and institutional engagement around UDA.
- Development of an emerging talent pipeline for underwater and maritime research.

4. Programme Design and Implementation

The internship model combined problem-based research with mentoring and knowledge exchange. Students were assigned to defined research themes and were expected to produce a final research output and presentation. This approach allowed the programme to maintain an applied orientation while giving students sufficient room to explore methods and develop their own analytical understanding.

The programme's research architecture can be understood through four stages: orientation, research engagement, knowledge exchange and dissemination. During orientation, students were introduced to the UDA context and the nature of the problem statements. During research engagement, they worked on datasets, models, literature and analytical tasks. Knowledge exchange occurred through interactions with MRC personnel and external experts. Finally, they consolidated the work through presentations and the World Oceans Day (and Final Presentations) showcase.

The final presentation stage was particularly important because it required students to move from doing research to explaining research. The documented presentations covered projects from four IITs, BITS Pilani and St. Stephen’s College. They demonstrated the range of research being undertaken within the internship.

4.1 Research-to-Dissemination Model

The programme's dissemination approach was consistent with the wider UDA principle of converting knowledge into usable understanding. The webinars for Final Presentations were not simply an end-of-internship ceremony; they gave students a platform to explain their work's relevance to experts and stakeholders. This is important for research in applied domains, where technical outputs gain more value when they connect to operational, policy, or environmental requirements.

5. Participating Institutions and Student Cohort

The documented internship portfolio includes students from IIT Bombay, IIT Delhi, IIT Madras and IIT Kanpur. We also welcomed a cohort of students from BITS Pilani (Pilani, Goa and Hyderabad campuses) and St. Stephen’s College. Representation across four leading technical institutions created a diverse academic base and enabled MRC to engage students working across different engineering, scientific and interdisciplinary disciplines.

IIT Bombay contributed projects in coral reef bleaching risk modelling, freshwater sediment transport modelling and artisanal fishing fleet detection. IIT Delhi contributed projects in passive sonar detection and classification, sediment-bearing pressure, satellite-based sediment concentration and subsurface observations for cyclone forecasting. IIT Madras contributed projects on riverine flood modelling and wind- and rain-driven ambient noise. IIT Kanpur contributed projects on passive sonar deployment and biofouling environment and succession. Further, students from BITS Pilani also contributed to similar projects– Quantifying biofouling risks for the upcoming Vadhavan port, Numerical Modelling of Shoreline Erosion in the Konkan Coast, Cable Segment Vulnerability Index (CSVI), etc. St. Stephen's College contributed through projects on Global Relevance of UDA, Blue Accounting Framework and MSP.

The institutional distribution also demonstrates that UDA research is not confined to one technical specialisation. The projects cover both marine and freshwater systems and span environmental, acoustic, geospatial and operational questions.

Institution	Documented projects	Primary themes
IIT Bombay	3	Coral bleaching; sediment transport; fishing fleets
IIT Delhi	4	Passive sonar; sediment; satellite remote sensing; cyclone observations
IIT Madras	2	Riverine flood modelling; ambient noise
IIT Kanpur	3	Sonar deployment; biofouling characterisation; biofouling succession
BITS Pilani (Pilani Campus, Hyderabad Campus and Goa Campus)	18	Shipping Radiated Noise (SRN) Estimation, Biofouling Management, Fisheries and Aquaculture, Sediment Management
St. Stephen's College	4	UDA in the new global order, Modelling and Simulation-based MSP; Blue Accounting Framework

Important Note: *Please note that few of the interns' projects are still undergoing assessment. Also, 3 interns (2 from IITs and 1 from St. Stephen's) discontinued their internships midway because of personal difficulties.*

6. Mentorship and Knowledge-Building

A core strength of the internship model was its emphasis on learning through interaction. Research in an applied field such as UDA requires students to understand not only the methods used in a project but

also the operational question behind those methods. Mentorship therefore served as the bridge between academic knowledge and applied research.

The wider internship-related lecture and knowledge programme brought students into contact with MRC personnel and external experts. The World Oceans Day documentation records presentations and keynote contributions from Dr. (Cdr.) Arnab Das, Shridhar Prabhuraman, and Rakesh Kumar of Bharat Electronics Limited; Professor Tomonari Akamatsu of Waseda University; Swati Meherishi of Springer Nature; and Vice Admiral G. Ashok Kumar and Ambassador Anup Kumar Mudgal.

Such interaction exposed students to perspectives extending beyond their immediate research tasks. The expert interventions emphasised the strategic significance of UDA, interdisciplinary collaboration, integrating scientific research into policymaking, emerging technologies, and the role of young researchers.

The knowledge-building component also encouraged students to understand the importance of communicating technical research clearly. This is particularly relevant for UDA, where scientific outputs may ultimately need to inform policymakers, operational agencies, technology developers, environmental managers, researchers and communities.

6.1 Learning Through Presentation

The final presentation requirement encouraged students to structure their research around a problem statement, methodology, observations and relevance. This process is valuable in itself: it requires researchers to distinguish technical detail from the central message of their work, explain assumptions, identify limitations, and articulate possible applications.

7. Research Portfolio and Thematic Areas

The twelve documented projects can be organised into connected thematic clusters. This thematic structure helps demonstrate how individual student projects contribute to the larger UDA research agenda.

7.1 Marine Spatial Planning and Environmental Modelling

The first cluster includes riverine flood risk management, coral reef bleaching risk modelling and related environmental intelligence. These projects use modelling and analytical techniques to understand how environmental conditions may evolve and where risks may emerge. The World Oceans Day documentation identifies MSP and environmental modelling as a major thematic group and notes the use of predictive analytics, acoustic technologies, and environmental modelling to strengthen UDA.

Such work contributes to a shift from reactive management towards scenario-based decision support. When environmental information can be spatially represented and modelled, stakeholders can explore possible outcomes and identify areas requiring intervention.

7.2 Acoustic Research and Passive Sonar

Acoustic research formed a second major component of the portfolio. Projects on passive sonar detection and classification, passive sonar deployment and wind- and rain-driven ambient noise address the challenge of understanding underwater soundscapes. The underwater environment depends heavily on acoustics because sound can propagate over distances where optical observation is limited.

The research also illustrates why environmental context matters to underwater sensing. Ambient noise generated by wind and rain can influence acoustic observations, while deployment and classification

questions determine how sensing systems can be used. Together, these projects support the broader objective of improving our ability to observe and interpret underwater environments.

7.3 Sediment Management

Three projects focused on sediment-related questions: machine-learning-based sediment transport modelling in freshwater systems, determination of sediment-bearing pressure using acoustic and sediment data, and satellite-based determination of sediment concentration in Ujjani Reservoir. The cluster shows how UDA extends into freshwater environments and into managing physical processes that affect infrastructure, navigation, ecology, and water systems.

The World Oceans Day documentation specifically groups these projects under sediment management and highlights sediment transport modelling, acoustic approaches and satellite-based monitoring as complementary approaches.

7.4 Biofouling Management

The biofouling projects examined both environmental characterisation and temporal succession. Varun Malviya's work addressed biofouling environment characterisation and maintenance gaps for strategic maritime infrastructure in the Andaman and Nicobar Islands, while Lovina Goyal examined monsoon-driven biofouling succession using parametric seasonal forcing of an MRC ODE framework. Together, the two projects address both the spatial and temporal dimensions of biofouling.

Biofouling has operational, economic and environmental implications. Understanding how environmental conditions influence fouling can support more informed maintenance planning and improve operational efficiency.

7.5 Fisheries and Aquaculture

The fisheries-related research included detecting and characterising small artisanal fishing fleets beyond AIS. This is particularly relevant because small vessels may not always be represented adequately in conventional vessel tracking systems. The project shows how satellite and analytical methods can strengthen fisheries monitoring and understanding of coastal activity.

The World Oceans Day thematic summary also identifies fisheries and aquaculture as a distinct research area and notes the relevance of emerging technologies to fisheries monitoring, resource management and coastal livelihoods.

7.6 Climate and Coastal Resilience

Climate-related research was represented by the riverine flood module and the study of subsurface ocean observation gaps in rapid cyclone intensification forecasting for the Bay of Bengal. These projects emphasise the importance of understanding environmental systems before and during extreme events.

8. Student Research Projects

This section provides a consolidated institutional summary of the twelve documented student projects. The descriptions below are based on the project titles, thematic documentation and research context available in the programme material.

8.1 Dev Raj Karan Singh – IIT Madras

Project: Riverine Flood Module for Tropical Major Basins.

The project focused on developing a riverine flood-oriented analytical module applicable to major tropical river basins. The work is relevant to UDA because riverine systems connect to coastal and marine environments, and because flood processes can affect communities, infrastructure, sediment movement, and downstream ecosystems. The project was presented as part of the internship research showcase.

The project demonstrates the value of bringing hydrological modelling into a broader UDA framework. A future development pathway could include integrating basin-scale flood intelligence with sediment transport, coastal inundation, and disaster-management datasets.

8.2 Mahaswi Ganipisetty – IIT Bombay

Project: Coral Reef Bleaching Risk Modelling for Arabian Sea and Bay of Bengal.

This project examined coral reef bleaching risk across two important Indian Ocean regions. Coral reefs are sensitive ecosystems influenced by temperature and other environmental conditions. Risk modelling can help identify vulnerable areas and support environmental monitoring and conservation planning.

Within the UDA framework, the project represents the environmental intelligence dimension of underwater awareness and illustrates how modelling can support sustainable marine resource management.

8.3 Ashish Kumar Jha – IIT Kanpur

Project: Passive Sonar Deployment Toolkit.

The project focused on the deployment dimension of passive sonar. While detection and classification address signal interpretation, deployment considers how sensing capability can be positioned and operationalised. This makes the work complementary to other acoustic projects in the cohort.

Together, the acoustic projects illustrate an end-to-end research pathway from environmental noise understanding and sensing to deployment and classification.

8.4 Pranav Ashok Mahitkar – IIT Madras

Project: Wind- and Rain-Driven Ambient Noise Layer for the IOR.

The project examined ambient underwater noise associated with wind and rain across the Indian Ocean Region. Environmental noise is an important variable in acoustic sensing because it can affect signal detection and interpretation.

By focusing on environmental forcing, the project provides an important context layer for passive sonar research and demonstrates how meteorological and oceanographic variables can be incorporated into acoustic analysis.

8.5 Sagar Yadav – IIT Delhi

Project: Determination of Sediment Bearing Pressure Using Acoustic and Sediment Data.

This project brought together acoustic information and sediment-related observations to investigate sediment-bearing pressure. This interdisciplinary approach reflects UDA research, where acoustic sensing can complement physical and environmental data.

The work was part of the sediment-management theme showcased through the World Oceans Day programme.

8.6 Aryan Singh – IIT Delhi

Project: Satellite-Based Determination of Sediment Concentration in Ujjani Reservoir.

The project investigated the use of satellite data to determine sediment concentration in a freshwater reservoir. Remote sensing can observe spatial patterns over large areas and complement field measurements.

The project illustrates the role of satellite-based environmental intelligence in supporting freshwater resource management and provides a useful example of how geospatial methods can complement acoustic and machine-learning approaches.

8.7 Varun Malviya – IIT Kanpur

Project: Biofouling Environment Characterisation and Maintenance Gap Analysis for Strategic Maritime Infrastructure in the Andaman and Nicobar Islands.

The project addressed biofouling in maritime infrastructure and examined the relationship between environmental conditions and maintenance requirements. The geographic focus on the Andaman and Nicobar Islands adds an important tropical island context to the research.

The work contributes to a practical understanding of how environmental characterisation can inform maintenance planning and infrastructure management. fileciteturn2file7L350-L353

8.8 Lovina Goyal – IIT Kanpur

Project: Monsoon-Driven Biofouling Succession – A Theoretical Analysis Using Parametric Seasonal Forcing of MRC ODE Framework.

This project examined the temporal progression of biofouling under monsoon-driven seasonal forcing. The use of an ODE framework provides a mathematical approach to representing succession over time and allows environmental forcing to be incorporated into the analysis.

The project complements the environmental characterisation work undertaken by the other biofouling intern and strengthens the cohort's focus on predictive and process-based understanding.

8.9 Shivam Gawande – IIT Bombay

Project: Detection and Characterisation of Small Artisanal Fishing Fleets in the Indian EEZ Beyond AIS.

The project focused on small artisanal fishing fleets that may not be adequately represented by Automatic Identification System data. Detection beyond AIS can support fisheries monitoring, coastal activity assessment, and resource management.

The project reflects the dual-use nature of UDA technologies, where remote sensing and data analytics can support both maritime awareness and civilian resource management.

8.10 Shiwang Gupta – IIT Delhi

Project: In-Situ Subsurface Ocean Observation Gaps in Rapid Cyclone Intensification Forecasting for the Bay of Bengal.

This project examined the role of subsurface ocean observations in understanding rapid cyclone intensification. The research highlights the importance of observations below the surface, where ocean conditions can influence atmospheric systems and forecasting.

The project contributes to the climate-resilience dimension of UDA and shows how improved underwater and subsurface observations can directly support disaster preparedness and early warning.

9. World Oceans Day 2026 Research Showcase

The World Oceans Day 2026 programme served as a major dissemination milestone for the internship. The event brought together expert discussion, student research presentations, and wider engagement on the future of underwater and maritime domains. The documented objectives included promoting awareness of the UDA Framework, exploring Marine Spatial Planning for sustainable ocean governance, showcasing student-led research, encouraging collaboration among academia, industry, policymakers and researchers, and marking World Oceans Day through meaningful dialogue on ocean sustainability.

The student presentations were organised around thematic areas rather than treated as isolated academic exercises. Marine Spatial Planning and environmental modelling, sediment management, biofouling management, and fisheries and aquaculture emerged as major groups. This thematic presentation helped demonstrate the interconnectedness of the research portfolio.

The event also gave students an opportunity to engage with experts representing multiple sectors. The documented expert panel included representatives from maritime security, academia, publishing, industry and diplomacy. Their observations highlighted the need for interdisciplinary collaboration, stronger links between research and policymaking, and greater use of emerging technologies in addressing underwater and maritime challenges.

9.1 Significance of the Showcase

The showcase transformed the internship from a closed research exercise into a knowledge-sharing platform. Students could present their work in a professional environment and gain exposure to perspectives beyond their academic institutions.

It also demonstrated the internship model's potential to build a wider research community. By bringing students, mentors, and experts together, MRC created an environment where project ideas could be discussed, refined, and potentially taken forward through future collaborations.

9.2 Documented Speaker and Presentation Record

The programme documentation includes speaker presentations from MRC leadership and external experts, followed by the twelve IIT student presentations and other presentations by students from BITS Pilani and St. Stephen’s College.

All the recordings of the presenters as well as the esteemed guests can be viewed in the webinar report attached below, for your reference:

- World Oceans Day 2026- Link here
- Final Presentations by IIT students- Link here
- Final Presentations by students with Liberal Arts background- Link here

10. Expert Engagement and Knowledge Exchange

Expert engagement expanded the intellectual context of the internship. The presence of experts from maritime security, academia, industry, publishing and diplomacy exposed students to different ways of understanding the same underwater challenge. A technically sound project may have implications for operations, policy, industry, environmental management or community livelihoods; expert interaction helps students recognise these connections.

The World Oceans Day discussions reinforced four broad messages: the strategic relevance of UDA; the importance of interdisciplinary collaboration; the need to connect scientific research with policymaking; and the opportunity to use emerging technologies to support the Blue Economy.

The participation of an industry representative such as Bharat Electronics Limited also provided an important perspective on technology and operational requirements. Academic and international perspectives, including those from Waseda University and Springer Nature, added dimensions related to scientific research and scholarly dissemination. The presence of a former senior maritime-security official and a former diplomat further widened the discussion around strategic and institutional relevance.

This diversity of perspectives is one of the most valuable features of the programme and should remain a core element of future internship cycles.

10.1 Research Communication as Capacity Building

The ability to communicate research is an essential professional skill. Students working on technically specialised topics must be able to explain their research question, approach and relevance in a manner that is accessible to stakeholders. The final showcase provided precisely this opportunity and can be considered an important component of capacity building rather than merely an event-management activity.

11. Outcomes and Contributions

The 2026 internship generated outcomes at individual, institutional and ecosystem levels. At the individual level, students gained exposure to applied research, data-driven methods, interdisciplinary problem-solving and professional research communication. At the institutional level, MRC strengthened engagement with four IITs, BITS Pilani and St. Stephen's College. It also created a documented portfolio of research themes. At the ecosystem level, the programme contributed to wider awareness of UDA and demonstrated how young researchers can contribute to underwater and maritime challenges.

The breadth of the research portfolio is itself an outcome. All individual projects cover environmental modelling, acoustics, sediment, biofouling, fisheries and climate resilience. This breadth indicates that the UDA framework can accommodate a wide variety of research capabilities while maintaining a coherent focus on understanding aquatic environments.

The programme also generated a foundation for further work. Some projects may be suitable for extended research, publication, prototype development, integration into existing MRC tools, or collaboration with external institutions. The final report should therefore be treated not only as a record of completion but also as a project-development document.

11.1 Institutional Contributions

For MRC, the internship strengthened the organisation's capacity to identify emerging research talent and develop academic partnerships. Student work can also contribute to the broader pipeline of ideas feeding into MRC's technology and research activities.

The programme's emphasis on real-world problems aligns with MRC's wider approach to UDA, which includes technology intervention, policy intervention and capacity and capability building. The UDA implementation philosophy emphasises moving from sensing to understanding and then sharing actionable insights with stakeholders.

11.2 Knowledge Contributions

The internship added to a growing body of MRC-linked work on underwater acoustics, environmental modelling, sediment management, biofouling, blue accounting, fisheries and coastal resilience. It also demonstrated the value of combining conventional engineering approaches with AI, remote sensing and mathematical modelling.

12. Capacity and Capability Building

The internship's capacity-building value extends beyond the technical output of individual projects. Students were required to engage with unfamiliar problem contexts, understand research literature, work with datasets and communicate results. These activities collectively support the development of research maturity.

Technical capability was strengthened through exposure to modelling, machine learning, satellite imagery, acoustic analysis and environmental datasets. Analytical capability was developed through problem formulation, interpretation of observations and comparison of methods. Communication capability was strengthened through presentation and interaction with experts.

The programme also supported interdisciplinary thinking. For example, the acoustic projects were not isolated from environmental conditions; ambient noise research provides context for passive sonar. Similarly, sediment research brought together machine learning, acoustics and satellite remote sensing. Biofouling research combined environmental characterisation with mathematical modelling.

This interdisciplinary orientation is particularly valuable for UDA because underwater challenges frequently cross institutional and disciplinary boundaries.

12.1 Professional Exposure

Interaction with MRC researchers and external experts exposed students to professional expectations around research quality, presentation and relevance. The presence of experts from academia, industry, maritime security, publishing and diplomacy also helped demonstrate the variety of career and collaboration pathways available within the broader maritime ecosystem.

12.2 Building a Research Culture

A successful internship should leave students with more than a completed project. It should encourage curiosity, documentation, peer learning, critical questioning and a willingness to continue exploring the field. The 2026 programme's emphasis on presenting research to a broader audience helped reinforce this culture.

13. Integration with our UDA Ecosystem

The internship should be understood as one component of MRC's wider research, technology and capacity-building ecosystem. MRC's UDA approach brings together environmental understanding, technology, policy and stakeholder engagement. The internship contributes primarily through research and capacity building, while creating opportunities for future technology and policy interventions.

The connection is visible across the student portfolio. Acoustic projects complement MRC's wider work in Underwater Radiated Noise, passive sonar and acoustic habitat understanding. Sediment projects connect with freshwater and coastal sediment-management work. Fisheries research relates to potential fishing zones and maritime monitoring applications. Environmental modelling connects with Marine Spatial Planning and disaster-management applications. Biofouling research supports maritime operational efficiency and infrastructure management.

This integration provides an important pathway for future cohorts. Instead of developing projects independently, internship problem statements can increasingly be linked to defined MRC research questions, existing datasets, tools and ongoing collaborations. This would enable students to contribute more directly to institutional research while retaining the educational character of the internship.

13.1 From Student Project to Institutional Research

A structured post-internship pipeline could classify completed projects into four categories: projects requiring further validation; projects suitable for publication; projects suitable for prototype or tool development; and projects that provide foundational datasets or literature reviews for larger research initiatives.

Such a pipeline would help ensure that internship outputs remain useful after the cohort concludes. It would also give students clearer opportunities for continued engagement through research papers, advanced internships, project collaborations or higher studies.

13.2 UDA and Capacity Building

Capacity building is one of the core pillars of MRC's implementation philosophy. The wider UDA approach recognises that policy and technology alone cannot produce sustained transformation without people possessing the knowledge and skills to use them.

14. Learnings and Areas for Improvement

The 2026 internship demonstrates the value of combining applied research with expert interaction and public dissemination. At the same time, the programme can be strengthened by formalising several processes for future cohorts.

1. First, project documentation should be standardised. Every intern should submit a common research template covering problem statement, literature review, dataset description, methodology, validation, results, limitations, future scope and references. This will make cross-project comparison easier and improve institutional archival quality.
2. Second, project milestones should be established at the beginning of the internship. A proposed sequence would include problem-definition approval, methodology review, mid-term presentation, technical review, draft report and final presentation.
3. Third, the programme can benefit from a stronger repository structure. Code, datasets, presentations, reports, figures and references should be stored systematically, subject to

permissions and confidentiality requirements. This will reduce knowledge loss when interns leave.

4. Fourth, student outcomes should be tracked after the internship. Follow-up information on publications, higher studies, projects, continued research or collaboration would help MRC assess the longer-term impact of the programme.
5. Fifth, where feasible, students should receive greater exposure to field observations, demonstrations or technology platforms. Even a limited field or laboratory component can help connect computational research with physical underwater realities.

14.1 Research Quality and Validation

Future cohorts should place greater emphasis on validation. Projects involving machine learning, modelling or remote sensing should specify validation datasets, accuracy measures and limitations. Acoustic projects should document environmental assumptions and deployment conditions. This will improve scientific reproducibility and make outputs more suitable for publication or institutional adoption.

15. Recommendations for Future Cohorts

The UDA Summer Internship should be retained as a recurring MRC capacity-building and research programme, with a progressively more structured research architecture.

- Develop a formal annual UDA Internship Handbook covering programme objectives, timelines, ethics, data use, reporting and presentation requirements.
- Publish a curated set of research problem statements linked to active MRC/UDA research priorities before the application cycle.
- Introduce a common research proposal and milestone-review format for all interns.
- Assign a primary mentor and, where possible, a technical co-mentor to each project.
- Introduce a mid-term research review to identify methodological challenges early.
- Create a central digital repository for reports, presentations, datasets and code, subject to access controls.
- Maintain an annual World Oceans Day or equivalent research showcase as the public dissemination milestone.
- Develop a formal post-internship pathway for publication, extended projects, prototypes and research collaborations.
- Track alumni outcomes to build a UDA student and young-researcher network.
- Increase exposure to field observations, demonstrations and operational use cases where feasible.
- Encourage interdisciplinary teams for selected problem statements, rather than limiting every project to a single discipline.
- Develop project briefs that explicitly identify potential stakeholders and eventual application pathways.

These recommendations are intended to strengthen continuity and institutional learning while preserving the exploratory nature that makes internships valuable.

15.1 Proposed Internship Cycle for 2027

A future cycle could be organised across six stages: outreach and selection; orientation and problem-definition; technical mentoring; mid-term review; final research and documentation; and public dissemination. The cycle should culminate in a formal research showcase and an annual compendium documenting the cohort.

16. Conclusion

The UDA Summer Internship 2026 provided a structured platform for young researchers to engage with contemporary challenges across the underwater and maritime domains. The documented portfolio of students' projects demonstrates the breadth of research that can be undertaken under the UDA framework, ranging from acoustics and environmental modelling to sediment management, biofouling, fisheries and climate resilience.

The programme's value extended beyond the individual research projects. Through mentoring, expert interaction and public presentation, students were introduced to the broader ecosystem in which underwater research operates. The World Oceans Day 2026 showcase provided an important bridge between student research and wider conversations involving maritime security, academia, industry, publishing and diplomacy.

The internship also reinforced the relevance of interdisciplinary research. The underwater environment is shaped by physical, biological, acoustic, climatic and human factors, and effective awareness therefore requires multiple forms of knowledge to be brought together. The 2026 cohort demonstrated how emerging technologies and analytical methods can contribute to this objective.

For MRC, the programme represents an investment in research capacity and in the next generation of underwater and maritime researchers. Its long-term value will be strengthened by creating mechanisms through which promising student projects can transition into extended research, publications, technology development or future collaboration.

The UDA Summer Internship 2026 therefore stands as both a record of student achievement and a foundation for continued capacity building. By connecting young researchers with real-world problems, experienced mentors and a wider community of practice, the programme contributes to the broader objective of building a stronger, more interdisciplinary and application-oriented UDA ecosystem.

Annexure: Student and Project List

Students from IITs

Group 1 projects: Marine Spatial Planning	
1	**Dev Raj Karan Singh from IIT Madras:** Presentation on "Riverine Flood Module for Tropical Major Basins."
2	**Mahaswi Ganipisetty from IIT Bombay:** Presentation on "Coral Reef Bleaching Risk Modelling for Arabian Sea and Bay of Bengal."
3	**Premkumar Narayan Tambekar from IIT Delhi:** Presentation on "Passive Sonar Detection and Classification System."
4	**Ashish Kumar Jha from IIT Kanpur**: Presentation on "Future Climate Modelling and Coral Reef Bleaching."
5	**Pranav Ashok Mahitkar from IIT Madras:** Presentation on "Wind- and Rain-Driven Ambient Noise Layer for the IOR."
Group 2: Sediment Management	
6	**Disha Gugale from IIT Bombay:** Presentation on "Sediment Transport Modelling of the Brahmaputra River."
7	**Sagar Yadav from IIT Delhi:** Presentation on "Assessment of Marine Sediment Bearing Pressure."
8	**Aryan Singh from IIT Delhi:** Presentation on "Satellite-Based Estimation of Suspended Sediment Concentration (SSC) in Ujjani Reservoir."
Group 3: Biofouling Management	
9	**Varun Malviya from IIT Kanpur:** Presentation on "CleanHull- RL: Deep Reinforcement Learning for Strategic Ship Maintenance."
10	**Lovina Goyal from IIT Kanpur:** Presentation on "Biofilm Maturation and Marine Fouling Succession: Exploring Recruitment Dynamics in Tropical Marine Systems."
Group 4: Fisheries and Aquaculture	
11	**Shivam Gawande from IIT Bombay:** Presentation on "Detection and Characterisation of Small Artisanal Fishing Fleets in the Indian EEZ Beyond AIS."

12	**Shiwang Gupta from IIT Delhi:** Presentation on "Detection and Mapping of Fish Farms and Seaweed Cultivation Zones in Indian Coastal and Offshore Waters. "
13	**Samyak Kumar from IIT Madras:** Presentation on "*Marine Heatwaves (MHWs): Drivers, Predictability and Fisheries Impact on the Bay of Bengal*"

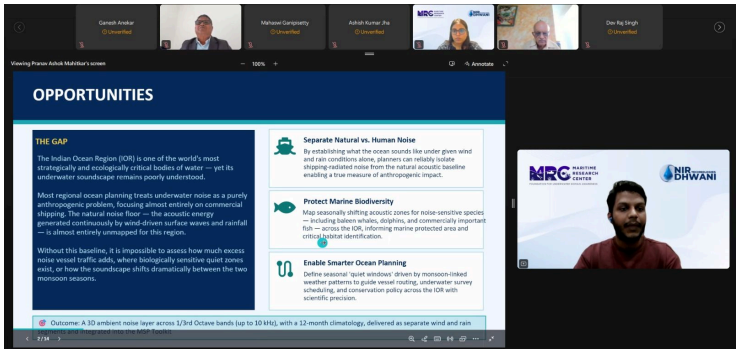
Students from BITS Pilani

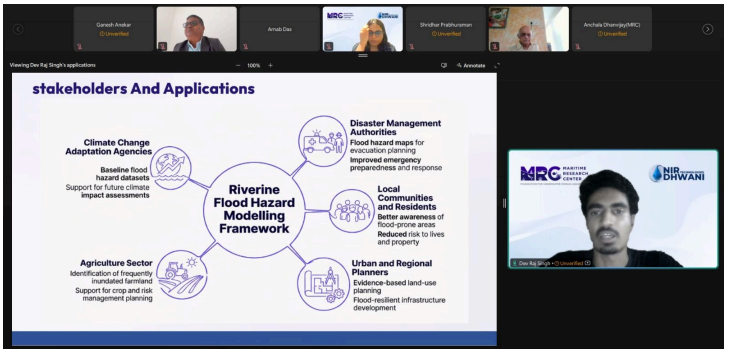
Group 1 ***(Mentored by Shridhar Prabhuraman, Deputy Director, MRC)***	
3	**Dhruv Kumar Sinha from BITS Pilani (Goa Campus)** on '3D Shipping Noise using ML'
4	**Yash Manin Kulkarni from BITS Pilani (Goa Campus)** on 'Cable Segment Vulnerability Index (CSVI)'
5	**Shreyansh Jaiswal from BITS Pilani (Hyderabad Campus)** on 'Sentinel-1 SAR Slick Detection and Prototyping'
6	**Ziyan Manzoor Sayyad from BITS Pilani (Goa Campus)** on 'Oil spill draft simulation and risk mapping'
7	**Omkar Raju Thote from BITS Pilani** on 'Integrating Habitat Suitability Model for IOR'
8	**Preena Senguta from BITS Pilani (Hyderabad Campus)** on 'Integrate Seagrass Extent and Change for IOR'
9	**Arnava Pradnesh Deshmukh from BITS Pilani (Goa Campus)** on 'Storm Surge module for IOR Coastlines'
10	**Tulika Abhijit Devale from BITS Pilani (Hyderabad Campus)** on 'Passive Sonar Deployment Tool- Effective Detection'
11	**Soham Saxena from BITS Pilani** on 'Passive Sonar Deployment Tool- Vulnerability Assessment'
12	**Anupam Sahai from BITS Pilani** on 'API service for Potential Fishing Zones'
Group 2 ***(Mentored by Romit Kaware, Research Fellow, MRC (IIT Delhi))***	
13	**Ayush Shukla from BITS Pilani (Goa Campus)** on 'Assessment of Inland Navigability in the Brahmaputra River'

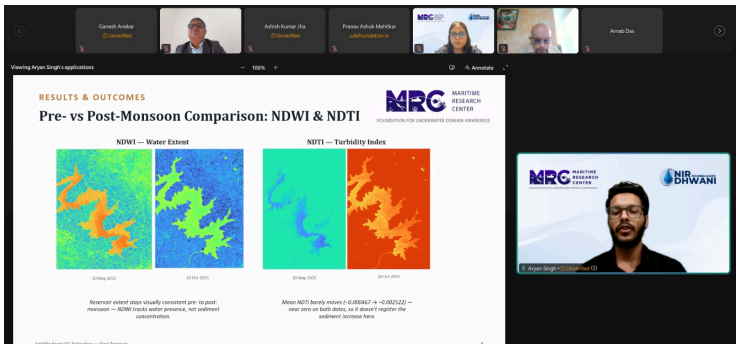
14	**Krishna Kishore D. from BITS Pilani (Hyderabad Campus)** on 'Numerical Modelling of Shoreline Erosion in the Konkan Coast'
15	**Pranahv Subramaniam Sankar from BITS Pilani (Goa Campus)** on 'AI-Assisted Dredging Assessment for Indian Ports Using Numerical Modelling'
Group 3 ***(Mentored by Suchir Mamidala, Research Fellow, MRC (IIT Madras))***	
16	**Sanchit Agrawal from BITS Pilani (Hyderabad Campus)** on 'Monsoon-Driven Seasonal Forcing of Marine Biofouling Succession in Indian Coastal Waters'
17	**Sri Siddhartha Yerramilli from BITS Pilani (Hyderabad Campus)** on 'Parameter Sensitivity Analysis of the Biofouling ODE Framework'
18	**Harshal Gorde from BITS Pilani** on 'Surrogate Modelling of the Biofouling Process'
19	**Anvi Mishra from BITS Pilani (Hyderabad Campus)** on 'Quantifying biofouling risks for the upcoming Vadhavan port'
Group 4 ***(Mentored by Ashwani Kumar Singh, Research Fellow, MRC (IIT Kanpur))***	
20	**Ishrit Jain from BITS Pilani (Goa Campus)** on 'Detection and Mapping of Fish Farms and Seaweed Cultivation Zones in Indian Coastal and Offshore Waters'

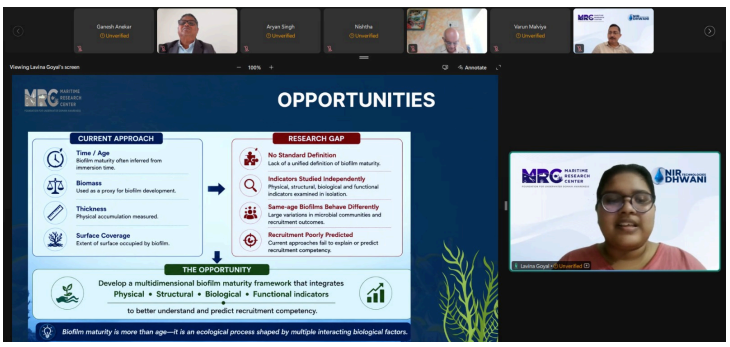
Students from St. Stephen's College

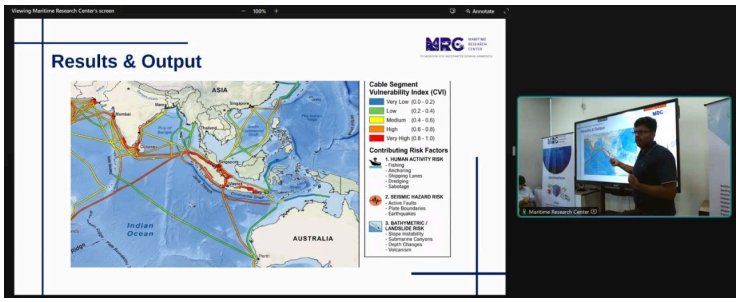
	Student' Name and Project
1	Ekta (MRC Intern; St. Stephen's College) The Global Relevance of UDA
2	Peter Baiju (MRC Intern; St. Stephen's College) Sector-Specific Analysis for the Blue Economy Assessment (BEA)
3	Vaibhav Sachan (MRC Intern; St. Stephen's College) Modelling and Simulation-Driven Marine Spatial Planning for India's Exclusive Economic Zone
4	Gunn Pahuja (Intern; St. Stephen's College) Assessing the social impact of UDA


OPPORTUNITIES
THE GAP
The Indian Ocean Region (IOR) is one of the world's most strategically and ecologically critical bodies of water — yet its underwater soundscape remains poorly understood.
Most regional ocean planning treats underwater noise as a purely anthropogenic problem, focusing almost entirely on commercial shipping. The natural noise floor — the acoustic energy generated continuously by wind-driven surface waves and rainfall — is almost entirely unmapped for this region.
Without this baseline, it is impossible to assess how much excess noise vessel traffic adds, where biologically sensitive quiet zones exist, or how the soundscape shifts dramatically between the two monsoon seasons.
Separate Natural vs. Human Noise
By establishing what the ocean sounds like under given wind and rain conditions alone, planners can reliably isolate shipping-radiated noise from the natural acoustic baseline enabling a true measure of anthropogenic impact.
Protect Marine Biodiversity
Map seasonally shifting acoustic zones for noise-sensitive species — including baleen whales, dolphins, and commercially important fish — across the IOR, informing marine protected area and critical habitat identification.
Enable Smarter Ocean Planning
Define seasonal 'quiet windows' driven by monsoon-linked weather patterns to guide vessel routing, underwater survey scheduling, and conservation policy across the IOR with scientific precision.
Outcome: A 3D ambient noise layer across 1/3rd Octave bands (up to 10 kHz), with a 12-month climatology, delivered as separate wind and rain

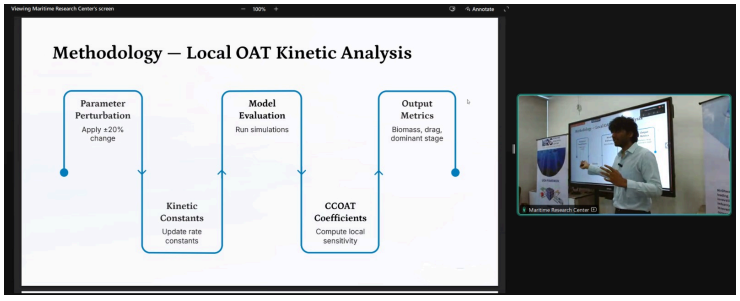

stakeholders And Applications
Riverine Flood Hazard Modelling Framework
Climate Change Adaptation Agencies
Baseline flood hazard datasets
Support for future climate impact assessments
Disaster Management Authorities
Flood hazard maps for evacuation planning
Improved emergency preparedness and response
Local Communities and Residents
Better awareness of flood-prone areas
Reduced risk to lives and property
Agriculture Sector
Identification of frequently inundated farmland
Support for crop and risk management planning
Urban and Regional Planners
Evidence-based land-use planning
Flood-resilient infrastructure development

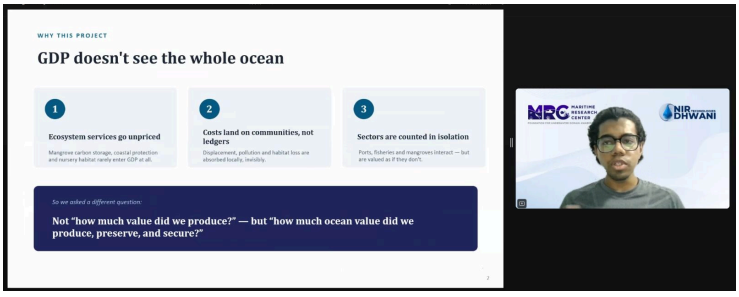

RESULTS & OUTCOMES
Pre- vs Post-Monsoon Comparison: NDWI & NDTI
NDWI — Water Extent
NDTI — Turbidity Index
Reservoir extent stays visually consistent pre- to post-monsoon — NDWI tracks water presence, not sediment concentration.
Mean NDTI barely moves (–0.000417 → –0.002522) — near zero on both dates, so it doesn't register the sediment increase here.

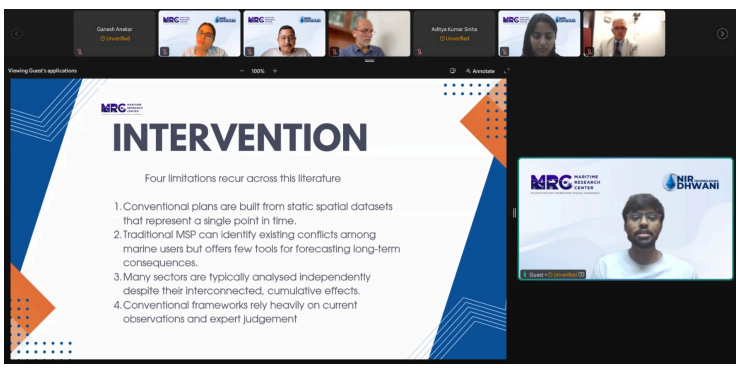

OPPORTUNITIES
CURRENT APPROACH
Time / Age
Biomass
Thickness
Surface Coverage
RESEARCH GAP
No Standard Definition
Indicators Studied Independently
Same-age Biofilms Behave Differently
Recruitment Poorly Predicted
THE OPPORTUNITY
Develop a multidimensional biofilm maturity framework that integrates
Physical • Structural • Biological • Functional indicators
to better understand and predict recruitment competency.
Biofilm maturity is more than age—it is an ecological process shaped by multiple interacting biological factors.

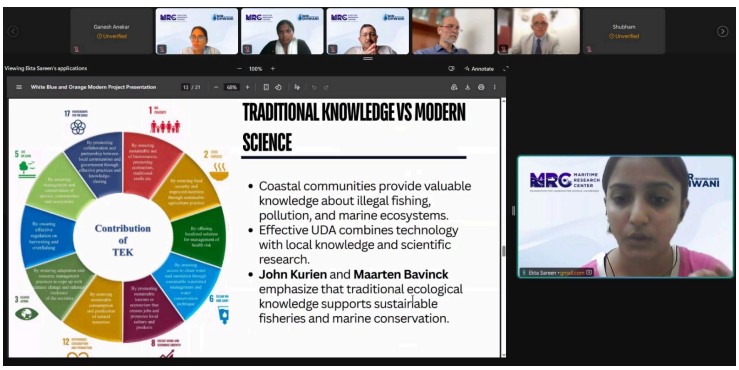

Results & Output
ASIA
AUSTRALIA
Indian Ocean
Cable Segment Vulnerability Index (CVI)
Very Low (0.0 - 0.2)
Low (0.2 - 0.4)
Medium (0.4 - 0.6)
High (0.6 - 0.8)
Very High (0.8 - 1.0)
Contributing Risk Factors
1. HUMAN ACTIVITY RISK
2. SEISMIC HAZARD RISK
3. BATHYMETRIC / LANDSLIDE RISK


The Indian Ocean Region's chronic dredging crisis
60%
95%
53%
Dredging Market Report 2026
CAGR 2026 - 2030
4.4%
$13.21 billion
$13.81 billion
$16.38 billion


Methodology — Local OAT Kinetic Analysis
Parameter Perturbation
Apply ±20% change
Model Evaluation
Run simulations
Output Metrics
Biomass, drag, dominant stage
Kinetic Constants
Update rate constants
CCOAT Coefficients
Compute local sensitivity


WHY THIS PROJECT
GDP doesn't see the whole ocean
1
Ecosystem services go unpriced
2
Costs land on communities, not ledgers
3
Sectors are counted in isolation
So we asked a different question:
Not "how much value did we produce?" — but "how much ocean value did we produce, preserve, and secure?"


INTERVENTION
Four limitations recur across this literature
1. Conventional plans are built from static spatial datasets that represent a single point in time.
2. Traditional MSP can identify existing conflicts among marine users but offers few tools for forecasting long-term consequences.
3. Many sectors are typically analysed independently despite their interconnected, cumulative effects.
4. Conventional frameworks rely heavily on current observations and expert judgement


TRADITIONAL KNOWLEDGE VS MODERN SCIENCE
Contribution of TEK
Coastal communities provide valuable knowledge about illegal fishing, pollution, and marine ecosystems.
Effective UDA combines technology with local knowledge and scientific research.
John Kurien and Maarten Bavinck emphasize that traditional ecological knowledge supports sustainable fisheries and marine conservation.