DETAILED REPORT

Underwater Domain Awareness

SUMMER SCHOOL - 2018

Unique Opportunity
for
Meaningful Engagement
for
Young India

Maritime Research Center, Pune

Savitribai Phule Pune University

Vidnyan Bharati, Pune

Goa University

Presents

Underwater Domain Awareness Summer School - 2018

"Unique Opportunity for Meaningful Engagement for Young India."

-: Date :-

04 June to 29 Jun in Pune

02 Jul to 13 Jul in Goa

-: Venue :-

Dept of Technology, SPPU

Dept. of Marine Sciences, GU

Associate Partners

NirDhwani Technology Pvt. Ltd.

NIO, Goa

NCAOR, Goa

Vidnyan Parishad, Goa

Convenor

Dr (Cdr) Arnab Das

Director, Maritime Research Centre

Organizing Partners

Maritme Research Center, Pune

Savitribai Phule Pune University

Vidnyan Bharati, Pune

Goa University

Sponsors

L&T Defence

Cochin Shipyard Ltd.

Associate Partners

NirDhwani Technology Pvt.Ltd.

NIO, Goa

NCAOR, Goa

Vidnyan Parishad, Goa

Organizational Structure

Mentors

- Dr RA Mashelkar, Former DG CSIR & President Global Research Alliance.
- Dr V K Saraswat, Former DG DRDO & Member Niti Ayog.

Advisory Committee:

- Dr G Satish Reddy, Scientific Advisor to Defence Minister.
- Shri Pradeep Rawat, Chairman National Shipping Board.
- Dr Anil Sahasrabuddhe, Chairman AICTE.
- Prof Nitin Karmalkar, VC Savitribai Phule Pune University.
- Prof Varun Sahni, VC Goa University.
- Prof. Suhas Pednekar, VC University of Mumbai.
- Shri Gollapalli N Rao, VC Andhra University.
- Prof Sunil Kumar Singh, Director National Institute of Oceanography.
- Shri Jayant D Patil, Director L&T's Defence Business.
- Shri Madhu S Nair, CMD Cochin Shipyard Ltd.
- Shri Pradeep Rathi, Founder, 3i Zone.
- Lt Gen (Dr) D B Shekatkar (Retd), President FINS.
- Vice Admiral SCS Bangara (Retd), MRC Adviser.
- Vice Admiral DSP Varma (Retd), MRC Adviser
- Shri Jayant Sahasrabudhe, National Organising Secretary, Vijnana Bharati.
- Dr. Prassana Kumar, Former Director NIO.

Organizing Committee:

- Shri Praful Talera, MRC Adviser.
- Shri Shrikant Kulkarni, Vidnyan Bharati Pune.
- Shri Suhas Godse, Vidnyan Parishad Goa.
- Dr Ashwini Kumar, NIO Pune.

Convener

- Dr.(Cdr) Arnab Das, Director MRC, Pune.

Co-Convenor

- Shri Kaustubh V Sakhare, Jt. Secretary Vidnyan Bharati, Pune.
- Prof. Aditya Abhyankar, HoD DoT Savitribai Phule Pune University, Pune.
- Prof C U Rivonkar, HoD Marine Science Dept, Goa University.

Table of Contents

List of Enclosures

1. Concept Note.
2. Detailed Weekly Programme.
3. Programme Details with Pictures.
4. List of Participants along with affiliations.
5. Project Summary.
6. Letter of Appreciation format.
7. Certificate format.
8. Feedback from Participants.

Background

The Indian Ocean Region (IOR) in the 21st century geo-strategic scenario emerges as a very critical sea area with global attention and presence of significant extra-regional powers. The massive movement of global logistics coupled with vulnerability to maritime piracy and terrorism has ensured military build-up in the region in-spite of a developing nation tag for almost all the nations in the IOR. The political instability and volatile socio-economic conditions make it a complex challenge for effective regional governance and sustained policy framework. Conflicts among nation states and emergence of the non-state actors have become a norm in the region impacting security and growth for all in the region.

The India in the 21st century is emerging as a maritime nation with significant focus on the maritime infrastructure development and also policy support for public-private participation. Multiple long term and huge maritime capacity and capability building projects are being initiated and pushed aggressively by the government. There is an effort to foster regional cooperation for progressing maritime growth. The Prime Minister in March 2015 made a very significant Foreign Policy declaration and coined the word Security and Growth for All in the Region (SAGAR). This gives a clear policy direction for all the stakeholders and entities within and outside the country to align themselves with the national vision. A first of its kind declaration at the highest level and we also see coherence in action and announcements by the government.

The Maritime Research Centre (MRC) has conceptualized the Underwater Domain Awareness (UDA) framework to provide a comprehensive structure for ensuring ***Safe, Secure and Sustainable Growth*** in the IOR. The UDA concept in itself is about monitoring the developments in the vast undersea domain in the IOR and initiate necessary action before an event takes place rather than merely record the event unfolding. There are typically four stakeholders that are directly relevant to the UDA framework – the national security apparatus, the blue economic entities, the environmental regulators and the disaster management agencies and finally the science and technology providers. In India, despite being a Maritime Nation with over 7,500 km of coastline, we have continued a continental mind-set both among policy makers and corporate entities. The vast maritime resources in the Exclusive Economic Zone (EEZ) spread across more than two lakh seventy thousand square kilometres is grossly underutilized. The much needed comprehensive Indian Maritime Strategy remains a work in progress.

The IOR with its tropical littoral conditions also present substantial technological challenges for the all the stakeholders. The undersea monitoring using sonar devices, suffer significant sub-optimal performance in the region due to severe medium fluctuations. The ongoing efforts to import high end technology from the west have failed due to degradation of performance when deployed in our waters. Indigenous development has been a non-starter in the absence of a coherent national policy and integrated approach by the stakeholders. The fragmented stakeholders approach has never facilitated significant resource deployment for science and technology development.

The UDA concept attempts to encourage a coherent approach and pooling of resources by the stakeholders for capability and capacity building in the underwater domain. The acoustic capacity is the major requirement to bring in effective UDA in the IOR overcoming the technology challenges and ensuring ***Safe, Secure and Sustainable Growth***. Effective UDA will certainly provide the necessary framework for the Prime Minister's vision of SAGAR.

India has to play a leadership role and with technological and strategic superiority in the region, India will be able to diplomatically leverage geo-political and geo-strategic issues. It may be stated that Energy Security and Food Security are a serious consideration when we look towards the IOR today.

The demographic dividend that we talk about, also presents itself as a major challenge to meaningfully engage the young India. The traditional career opportunities are not able to support the growing requirements and appropriate skilling and effective human resource development has remained a concern. The massive maritime push also brings much newer challenges that are not obvious to the conventional continental outlook that we have maintained in India since independence. The indiscriminate human interventions and growing climate change impinge on the ***safety*** worries for such huge investments. The volatile regional dynamics with involvement of state and non-state actors presents complex ***security*** concerns. The direct environmental impact of massive anthropogenic activities results in aspects like acoustic habitat degradation causing ***sustainability*** issues. The effective UDA could also allow much deeper understanding of the undersea resources and boost ***growth***.

The Maritime Research Centre (MRC), Vijnana Bharati (ViBha), Savitribai Phule Pune University (SPPU) and Goa University came together to organize a six-weeks project based UDA Summer School in Pune and Goa, to create awareness about the ocean and relevant technology driven maritime strategies with in-depth research and analysis. The organization of the UDA Summer School-2018 was supported by M/S NirDhwani Technology Pvt Ltd, National Institute of Oceanography (NIO) Goa and National Centre for Antarctica and Ocean Research (NCAOR) Goa, as associate partners. The theme for the UDA Summer School-2018 was “Unique Opportunity for meaningful Engagement of Young India”.

Objectives

The young India today is an extremely valuable but volatile asset with very high aspirations. The high energy needs to be channelized into meaningful nation building activities to positively engage Young India to the Growth path. The disconnect, between the academia and the industry and the lag between the strategic vision and human resource development in the country brings massive unrest among the aspirational young India. The requirements of the industries are somehow not understood by the academia and the large scale output from the universities finds itself inappropriately prepared to meet the corporate needs making them unemployable.

The academia in India has failed to include UDA in its curriculum. The multi-disciplinary nature of the UDA framework requires a comprehensive structure to address the complex requirements. Right from the Under Graduate (UG) to Post Graduate (PG) and also higher research at PhD levels the UDA concept has not been addressed effectively. The participation of our academia in field work is significantly minimal. The UDA formulation requires massive experimental efforts to generate data on the unique IOR realities to be able to solve real world problems. Acoustic Capacity building somehow has missed the attention of the policy makers at all levels. The fragmental approach by stakeholders and lack of coordination among academia, industry, think tanks and others makes it a complex problem. The lack of awareness of the UDA framework and its relevance is probably the main reason.

The diversity and geographical distance has ensured sea blindness for a large part of India that could possibly contribute significantly. The hinterland needs to understand the relevance of the oceans and bring maritime consciousness on a nationwide scale to ensure policy level changes. Young India needs to know and demand to make positive change. Project based approach is an accepted norm to ensure deeper understanding and sustainable impact. Coastal India alone cannot address the issues and continental India has to equally participate. The expanse of India's Exclusive Economic Zone is almost equivalent to the terrestrial component. To take India forward in the future, maritime India also has to contribute substantially to the growth.

Multi-disciplinary, multi-level and multi-organizational approach is the only way forward to address such an important issue of critical national relevance. Disciplines of technology, science, law, management, humanities and many more need to synergise their efforts to build an effective UDA framework. The mammoth size of our maritime and undersea region needs work at all level, like UG, PG and PhD to be able to cope with the requirements. The multi-level approach will facilitate team effort to comprehensively address the requirement. The multiple stakeholders in the public and private sector are not able to coordinate and synergize their efforts in the absence of a comprehensive national strategy. Effective communication across these multi-disciplinary, multi-level and multi-organizational components are extremely essential.

The start-up India is a flagship initiative of the government today and probably the best mode to address requirements of job-opportunities, innovative growth and entrepreneurship. The UDA framework can bring a very new dimension to the start-up India initiative. The massive maritime and undersea region in the IOR with its characteristic tropical littoral limitations can be addressed through the high end technology and innovative solutions. Sustainable entrepreneurship is the probably the most apt way forward and UDA presents huge opportunities in that direction.

The objectives of UDA summer school based on the above points can be summarized as:

(a) Generate awareness among academia, industries, research organizations, think tanks, policy makers, common people and more on the relevance of UDA.

(b) Project based internship to give deeper understanding of the issues and ensure a sustained impact.

(c) Multi-disciplinary participation to facilitate comprehensive research and analysis outlook towards problem solving.

(d) Multi-level participation to bring team work and differentiate levels of understanding and bring quality appreciation.

(e) Multi-organizational participation encouraged peer learning and cross pollination of ideas and understanding. Going forward, it will bring better coordination among these institutions and synergize their efforts towards nation building.

(f) Interaction with academic experts to gain good understanding of theoretical aspects and fundamental issues.

(g) Interaction with industry experts to appreciate the ongoing activities and opportunities and also apprise them of the expectations to make them more employable.

(h) Interaction with researchers from multi-disciplinary backgrounds to give deeper insight into real world problem solving and effective approaches.

(i) Interaction with strategic experts to give a very comprehensive view of the geo-political realities on the global scale and IOR and how to steer the strategic vision for India. Young India has to better prepare itself for the future.

(j) Field visits in terms of educational beach walk, research cruise, visit to maritime industry and more to give them a very comprehensive exposure to the UDA formulation to make a well informed decision on future options.

(k) Interaction with senior scientists and research labs to expose them to the ongoing work and also encourage scientific temper.

(l) Biodiversity walks both for terrestrial and marine to appreciate the interdependence and also impact of human intervention. The main agenda is to expose them to the richness in the nature and inculcate respect for the nature while shaping their future endeavours.

(m) Communication skills is also part of the curriculum to make the participants more effective in their expression of ideas and true ambassadors of the programme going forward.

(n) Start-up India needs new ideas and domains and structured innovation requires formal exposure to entrepreneurship and associated functions.

(o) Invite marine conservation experts with significant field work were invited to give an exposure to real issues in field and also introduce opportunities in the NGO space.

Conduct of the Programme

The commencement of the UDA Summer School preparation began with multiple presentations by Director MRC to multiple academic institutions to generate awareness on UDA and the Summer School. Presentations were made at diverse geographical locations from Guwahati, Nanded, Mumbai, Shegaon, Pune, Bangalore and many more. The enthusiasm of the young students and faculty members was extremely encouraging. Workshops and interactions were also carried out for the stakeholders from the Navy, Coast Guard, Industries, Research Institutions, Think tanks, etc.

MRC collaborated with Vijnana Bharati to make it a national programme and comprehensively address the multiple issues in taking such an ambitious initiative**.** Vijnana Bharati and MRC together approached heads of important institutions like All India Council for Technical Education (AICTE), Defence Research and Development Organization (DRDO), National Institute of Oceanography (NIO) and many more to get their feedback and guidance on the initiative and seek their support. Prominent scientists, strategist, academicians, industrialists, policy makers and others were consulted for shaping the event. The feedback on the relevance of UDA was encouraging and Summer School being the best mode of delivery was formalized. The advisory board and organizing committee were formalized to manage the event. The approved concept note for UDA Summer School-2018 is attached at enclosure-1.

The two stage programme with four weeks in Pune and two weeks field exposure in Goa was finalized. The Savitribai Phule Pune University at Pune assured complete support in hosting the Pune phase and offered to accommodate the participants and the programme in their campus. The Department of Technology (DoT) was deputed to be the coordinating department and became the venue. The Goa phase was hosted by the Marine Science Dept of the Goa University. The large part of the programme at Goa was conducted by NIO and the senior NIO scientists gave a very comprehensive exposure to ocean science, diversity and morphology. NCAOR also conducted a detailed workshop on their activities and unique research features and opportunities. The Marine Science Dept at the Goa University conducted a research cruise for the participants in spite of the inclement weather in Goa with the onset of monsoon.

The participants were exposed to Data Science, Acoustics, Signal Processing, Coastal Engineering, Robotics, Policy matters, Geopolitics, Biodiversity and more by using the expertise from the academia, research organizations, industries and different strategic think tanks. The resource persons were carefully chosen to manage the diverse composition of the participants and also balance quality and quantity. The project based internship brings ownership among the participants and keeps their curiosity alive for a six weeks programme. The detailed weekly programme is attached at enclosure-2 and the detailed programme report with pictures is attached at enclosure-3. The list of participants and their affiliations is attached at enclosure-4.

The programme started with introduction to the broad framework of UDA and interaction on possible project ideas based on their discipline and level of understanding. Care was taken to justify the background of the participant based on their academic qualification and professional background, while allocating the projects. The participants were encouraged to continue the project work even post completion of the summer school and assured all support and guidance at the MRC. To enable the participants to effectively steer their project, they were given hands on exposure to data science, Matlab and Python. Experts from IIT Bombay, Math Works and Intel undertook the three day workshop. Additionally they were exposed to various aspects of

the marine and maritime sector through classroom lectures, presentations and interaction with experts and practitioners. Project discussion with senior mariners and maritime domain experts helped them to shape their projects. Certain non-marine related research labs visits and expert interactions was also arranged to broaden their horizon.

The Goa phase was more focussed on field trips and exposure to experimental research. The marine science Dept at the Goa University organized a detailed exposure to various facets of marine science through classroom lectures and research cruise. The NIO undertook detailed exposure on shallow and deep water research in the IOR for the participants. Very senior scientists engaged with the participants on various disciplines and also accompanied them for field trips. NCAOR also conducted a detailed presentation and visit to their research facilities. The participants got exposure to other maritime industries namely the Marmugoa Post Trust (MPT), Goa Shipyard and a manufacturing industry of global standard located in Goa. The visits gave them a chance to ascertain the real world relevance of the projects being undertaken by them. The field visits were planned in a manner so that they could ask meaningful questions and also get a first-hand experience of the technology requirement and deployment in the maritime sector. The policy formulation, technology & innovation and human resource development agenda of the entire UDA Summer School was comprehensively addressed.

The participants presented their projects to an eminent panel of experts:

(a) Dr. Prassana Kumar (Physical Oceanographer), Former Director of NIO,
(b) Dr. Baban Ingole (Marine Biologist), Former Scientist NIO,
(c) Shri Jayant Sahasrabuddhe, Organizing Secretary Vijnana Bharati
(d) Shri Praful Talera, Industrialist and MRC Adviser on Blue Economy

Projects

The projects were finalized in consultation with the participants based on their interest, discipline, academic background, geographical location, organization represented, understanding of the issues, future opportunities and more. The projects were shaped to solve real world problems and address contemporary issues. The UDA framework addresses the issues related to both freshwater systems and marine zones in the IOR. The main agenda was Acoustic Capacity Building to enhance UDA in the IOR.

The five students from Guwahati were motivated to take up projects from their region. The river Brahmaputra is a mighty river flowing through the state of Assam with significant influence on the culture and economic growth of the region. The ongoing river linking project being pursued by the Government of India has focussed on the river Brahmaputra and the National Waterway No. 2 from Sadia to Dhubri is being developed ambitiously. The massive investments on the Inland Water Transport (IWT) system being developed to optimally utilize the River Linking project demands nuanced strategic vision. The uniqueness of the region have been studied and following issues merit attention:

(a) The region is seismic prone and requires effective monitoring mechanisms for early detection to minimize damage in case of any incident. Safety concerns are paramount.

(b) The region is prone to subversive activities by various groups being backed by our adversaries. The security threats are real and deserve attention.

(c) The River Dolphins in the Brahmaputra are very unique but extremely endangered. They are blind and depend on sound for multiple biologically critical functions. Thus, Acoustic Habitat Degradation is a major concern when we look at such massive projects on the river.

(d) The Brahmaputra River is known to loose altitude when it enters the Indian Territory. The high flow rate of the river is accompanied by heavy siltation and thus ensuring safe navigable waters across the year is a major challenge.

(e) The Oil and Gas companies are actively engaged in exploitation of natural resources in the region. The activities are accompanied by underwater noise that have direct impact on the aquatic species.

(f) The IWT vessels that will operate in high volumes will have their significant contribution towards impacting the marine ecosystem and Acoustic Habitat Degradation which will be inescapable.

The five BTech (Electronics and Communication) students were allocated projects that address the multiple aspects of the growth being pursued on the Brahmaputra River. There is potential to take forward the work, back in their final semester and also connect to the local industry and NGOs for future opportunities as they are final year students.

The two computer science (CS) UG students from Nagpur showed significant interest in Geo-politics and contemporary maritime issues. They took up a project to address the critical crisis of illegal migration through the sea-route. They came up with this project on their own and could correlate with their algorithm development skills being CS students. Their passion for

the project topic and considering they are third year UG students, there is potential to work and take the work to a matured level on their own.

The PG student in Signal Processing from Pune has some exposure to Underwater Signals and chose to work on Radiated Noise Analysis with automated analysis software development. The project will be extremely critical for multiple other projects on Acoustic Habitat Assessment of the River linking project. As PG student in an institute associated with the DRDO, he will be able to present deep research and analysis for defence and civilian applications.

The electronics student from Nanded decided to take up study of underwater drones and their applications in the IOR. The student has finished her degree and is in search of opportunities, thus having a broad idea on the drones makes her more eligible for project position in research institutes like NIO, NCAOR and even DRDO with similar work.

The student with Masters in Microbiology took up project on Impact of Anthropogenic Noise on the micro-species. The massive maritime build-up in the IOR is likely to have significant impact on the eco-system and the micro-species are equally important to be studied. Again she has completed her degree and looking for opportunities, so her broad understanding of the Underwater Domain and relevant contemporary issues make her eligible for project positions to shape-up her future career.

The Naval Architect from Shipyard took up study of vessel design and its impact on the Acoustic Habitat Degradation. His domain knowledge and organizational position makes him extremely valuable to study the IWT project and the ship design aspects for sustainable growth. He will be able to take forward his project even post joining back his shipyard.

The officer from the Indian Coast Guard (ICG) also took up project relevant to his organization. He will be pursuing the project even post joining back. His project is extremely relevant to the mandate of ICG and will add new dimension to the ongoing efforts in his organization.

The three PhD aspirants took up projects that could define research problems for their future research. They were able to shape their research ideas and also possibility of data availability with experimental field data to ensure strong publications. They learnt problem formulation and paper writing in addition to formalizing their research problem.

The Marine Archaeology student could interact with specialists at NIO and also participated in a field visit for data collection. She is working on technology intervention and regulatory template for underwater archaeological surveys. The maritime law professional worked on regulatory framework for Anthropogenic Noise in the IOR. A participant with very significant understanding of maritime law added a new dimension of underwater noise into his portfolio. The mechanical engineer with a Master's degree worked on the bubble dynamics for propeller cavitation. This has significant influence on radiated noise and also acoustic habitat degradation aspects.

Each of the participants worked diligently on their projects and displayed significant motivation while working on their ideas. They interacted very meaningfully with the experts and resource persons. The six weeks programme did not cause any fatigue due to their strong attachment to the projects. The new domain of UDA and hectic schedule did not deter them at all and all of them maintained high energy throughout the programme. The collaborative approach and meaningful exchange among the participants in pursuing their projects and also

overall learning across disciplines facilitated effective peer learning. The participants displayed perfect harmony among each other in-spite of diverse cultural, academic and geographical backgrounds. Details of the projects along with a summary by the participants are attached in enclosure-5.

Logistics

The wheels for the UDA Summer School-2018 started rolling with the online registration. Online registration link along with concept note, google form for registration and online payment details was uploaded and circulated through WhatsApp, social media, direct contact with organizations and other networks. Online registration and other communication with the participants was coordinated by Mr. Pratik Baheti. A WhatsApp group was made for the convener and the participants to manage all the schedule related communications. Another WhatsApp group was also made for the organizing team to coordinate all the event related issues. A separate email id (udasummerschool@gmail.com) managed by the convener for the formal communication with resource persons, sponsors and well-wishers was opened. Another email id (c.udasummerschool@gmail.com) managed by the online coordinator for internal communication with the participants was also opened.

The complete accounts management was supported by Vidnyan Bharati Pune team. The registration fee from the participants and the sponsorship amount was deposited to their account and all expenses were drawn from the same account under their audit regulations. It was clarified from their Chartered Accountant (CA) that no GST is applicable as it is an educational programme with no profit motive. A detailed budget was made and all expenses accounted for by the convener and discussed with all the organizing team members. The organizing team approached maritime corporate entities for sponsorship support and also logistic support to its partners to minimize the expenses. Once the registration fee was paid along with a nominal charge for logistics, all expenses were borne by the organizing team, including boarding and lodging and also transportation for all activities and movement in Goa.

The L&T Defence came forward to support the UDA Summer School initiative and offered to sponsor part of the event. The Cochin Shipyard Limited (CSL) also came forward and offered to sponsor part of the event. The Pune University generously supported the event and the VC approved hosting the Pune phase of the event at no cost to the organizers. The accommodation for the participants and resource persons at the UGC Guest House within the SPPU campus and the venue at the Dept of Technology (DoT) was offered to UDA Summer School for the entire four weeks duration. The Goa phase was hosted at the Goa University campus and the participants were accommodate at the old Guest House. The Director NIO approved hosting of the convener and the resource persons at their guest house for the entire Goa Phase and also meals and tea for the participants for all the five days at NIO. A dinner for the participants and few dignitaries as part of an informal interaction with the Director NIO was also hosted at NIO.

The local travel was minimized by choosing the venue closer to the accommodation for the participants. The resource persons were also accommodated at the same Guest House. The resource persons continued their interaction with the participants till late evening as they were staying together. A private bus was hired for the field visits at Goa for a duration of six days. The movement from Pune to Goa was collectively booked in a private Volvo Bus and the interfacing travel was undertaken using taxis coordinated by the organizing team.

The entire day today coordination on site was managed by Ms. Tiya Chatterji for the entire six weeks. She was assisted by Mr. Varun Shaligram. The social media communication and photography was managed by Ms. Dimple Khilwani and assisted by Mr. Varun Shaligram. The event presentation was prepared by Mr. Ankit Viswas and assisted by Ms. Dimple Khilwani. The participants took ownership of the programme and came forward to take up responsibilities on many occasions.

The participants were awarded a letter of appreciation to remain connected to the UDA initiative by the Director MRC on successful completion of the programme by them. The format of the same is attached at enclosure-6. A certificate signed by heads of all the organizing partners was also awarded in recognition of their participation and project undertaken. The format of the certificate is attached at enclosure-7.

Conclusion

The UDA Summer School-2018 was a wonderful experience for the organizing team and particularly the convener. The positivity and the cordial exchanges that happened during the entire event will surely spread very encouraging messages for long time to come. We have achieved to form a UDA Summer School team for the future. The participants will not only be ambassadors but also remain a pillar of support for the future ventures. The messaging has been extremely powerful and the partners, associates, stakeholders, sponsors, well-wishers and lot many more entities and future collaborators value the relevance of the programme and also appreciate the design and conduct of the event. All the objectives that were planned have been achieved and the learning that has happened in the course of the event both tangible and intangible have given a big boost to all concerned.

UDA Summer School will remain a flagship programme for MRC and will continue to collaborate with all the partners to deliver far more value to the participants in future and also contribute significantly to the nation building cause. There is need to consolidate and evolve a template for the logistics and well defined modules for the programme. Structured objectives and delivery needs to be planned to comprehensively address the entire objectives. The long term team building and strong connect to the UDA framework delivery needs to be planned and implemented. UDA Summer School will become the starting point and entry level for all participants to ride the UDA initiative. Institutionalization of the UDA initiative and UDA Summer School being an important component of the entire UDA initiative.

Going forward, we envisage the following to be considered while planning UDA Summer School for next year:

(a) Expand the representation of the participants from the stakeholders and be able to add participants from every possible stakeholder in India. Peer learning and cross pollination to be complete.

(b) To be able to connect all Coastal Universities into the programme and have representation from as many institutes to support long term programmes in these institutes. Student projects and sponsored projects on UDA can be housed in these institutes to develop expertise. UDA can be made part of their academic curriculum and credit allocation for attending UDA Summer School may be considered.

(c) Representation from all Central Universities to be able to connect all geographical regions to the UDA initiative.

(d) Participation from IOR rim nations need to be encouraged and connect diplomatically to these nations. Science and technology can be a very strong diplomatic tool to connect nations in the region and find solutions to multiple security and growth related problems in the region. This can truly support the SAGAR vision of the honourable Prime M.

(e) Seek permanent partners for the UDA Summer School organizing team. Partners need to be from cross section of institutes from government to private sector. Academic institutes, research institutes, regulatory bodies, industries, environmental groups, logistics, media and many more.

(f) Fellowship programmes sponsored by stakeholders needs to be instituted to allow incentive for the participants to look forward to in future.

(g) There should be strong connect with the corporate entities associated to the UDA framework, so that the modules can be made more relevant to their human resource requirement. The future opportunities for the participants get addressed more effectively and young India get another avenue to contribute to the nation building requirement. Employability improves in a very effective manner.

(h) A growth path from UDA Summer School to internship, internship to fellowship, fellowship to project position, project position to higher degree enrolment and subsequent employment at a respectable position with substantial contribution to indigenous science and technology development needs to be evolved.

(i) The institutes of eminence within India, relevant to UDA need to be connected as the participants will get a comprehensive exposure to all such institutes to pursue their future endeavours. These institutes could be academic, research related, corporate entities, regulatory bodies, NGOs and more. Resource persons from these organizations and possible visit may be considered.

(j) Select few institutes of eminence globally also need to get connected to the UDA Summer School to upgrade the quality. UDA Summer School should become a global brand.

Concept Note

Underwater Domain Awareness (UDA) Summer School
Six Weeks Project Based Internship Programme – 04th Jun to 14th Jul 2018

We seek a future for the Indian Ocean that lives up to the name of
"SAGAR-Security And Growth for All in the Region."
Shri Narendra Modi. Mar 2015

Background

The young India is a very critical asset that we all talk about today and globally India is being recognized as an emerging nation that cannot be ignored on any front. The young India also poses a big challenge to channelize the abundance of energy in the right direction for nation building. The employability of the graduate students with appropriate skills and understanding of the contemporary issues facing the nation is an important aspect that merits attention.

Science and technology will remain a critical driver of national interest and the young India needs to get exposed to finer aspects beyond the theoretical knowledge to make a difference. Focussed and application oriented, project-based learning has always been recognized to make deep impact in the process of learning. Student internship programmes are the right instruments to realize this mission.

The government today has taken multiple steps to build maritime infrastructure and integrate the maritime domain with the economic growth engines. The entire government machinery has presented significant intent and action in driving project to realize the SAGAR vision. However, it needs to be recognized that such massive projects require human resource at equally big scale. The high-end technology aspects need focussed and sustained efforts.

Underwater Domain Awareness (UDA) is a framework that addresses the aspect of ***Safe, Secure and Sustainable Growth*** in the maritime region particularly for the Indian Ocean Region (IOR). UDA is very well aligned to the SAGAR vision of the honourable PM. It encompasses the ideas of smart digital India with high end technology integration to overcome the specific challenges of the IOR. Details on UDA is attached at the end of the document.

Proposal

UDA Summer School proposes to organize a ***six weeks Summer Internship*** wef 04 Jun till 14 Jul 2018, for under/post graduate students undergoing technology programmes. It will be a multi-disciplinary project-based programme to expose the participants to multiple issues of the technology based real world problem solving. It will be driven by the UDA framework in the IOR. It will be relevant to disciplines like:

- Electrical and Electronics Engineering,
- Computer Science/Engineering and Information Technology,
- Instrumentation, Acoustics and Geo-physics
- Mechanical Engineering,
- Communication and Signal Processing,
- Marine Biodiversity, exploitation and potential for drug extraction

The participant will be able to take the work forward to their BTech/MTech projects and MRC will be happy to support them for that post the internship. The participants will get exposure to the relevant stakeholders including industries, research organizations, strategic think tanks, users and more as part of the internship programme to be able to understand the requirements and also facilitate their skills to make them employable. Domain experts will interact with the participants and also guide them in the course of their projects. There is a two weeks field visit to Goa planned as part of the internship where the participants will visit NIO, NCAOR, Marine Science Dept. at Goa University, marine industries and also take part in a short Research Cruise.

The project execution will also be supported by dedicated technology exposures on Data Science, Acoustics, Signal Processing, Statistics, Policy matters, Geopolitics, Biodiversity and more by the relevant experts. Guest lectures will be organized on regular basis to give a comprehensive exposure. Regular lectures on communication/soft skills and hands-on software programming sessions will be organized. Detailed academic programme will be given separately.

Eligibility for the programme will be BTech students and MTech students. Publication of the work in appropriate journal/conference will be encouraged and guided. The institutes may collaborate with MRC to continue the support for their students for completion of their BTech/MTech project on the same work. Individuals desirous of PhD in this new area may also join the programme.

Certificate will be awarded to the students on successful completion of the programme with special mention of research and industry exposure. Meritorious students may be offered research associate position, post completion of their degree on specific projects being pursued by MRC. Suitable cash prizes will be awarded to the participants under various categories.

Conduct of the Programme

The broad nationwide relevance of the programme entails that we should be able to expose students from different parts of the country to participate and take back the message to their location. The programme will be conducted at Savitribai Phule Pune University (SPPU) Pune with two weeks field visit to Goa.

Young faculties from some of these institutes, who join will be given special exposure to higher research areas to enable them to formulate thesis ideas. They could pursue their PhD under the guidance of MRC and they will be fully supported with infrastructure and data. These

faculties could subsequently take back these ideas to their students and become ambassadors of the programme on a nationwide scale.

Fees Structure

The fees structure for the programme will be as follows:

(a)	Students	-	Rs. 20,000/-
(b)	Professionals	-	Rs. 25,000/-

Daily meals and logistics in addition to the academic programme will be arranged for the participants as part of the registration fee. Participants will join the programme at Pune and depart from Goa at the end of the programme. Institutional participants will registered under a special package under institutional MoU with MRC for a long term research support. Details will be worked out separately.

Accommodation

Basic shared accommodation will be arranged for the entire duration at a nominal fee of Rs. 5,000/-.

Detailed Programme

The six weeks programme will be broken down as follows:

Week-1 Project Identification

The first week will comprise of orientation into the broad framework of Underwater Domain Awareness (UDA). The participants will be given classroom lecture and also provided literature on the subject. The mentor will associate with them to help them understand the domain and identify project ideas. The end of the first week will formalize their project ideas.

Week-2 Interaction with Domain Experts

In the second week, the participants will interact with domain experts to orient them to the world of UDA and the Maritime sector. The domains will include geopolitics, science and technology, strategy, maritime diplomacy, India and where we are (official speak), and more. The participants start getting mature with their project ideas.

Week-3 Literature Review and Project Formalization

This week will be focused on the project again to collate the information they got from the experts and their own understanding. The participants have to do a thorough literature survey and evolve their thought on the project formulation. The participants will make presentations to panel of experts and the coordinator while formalizing their project ideas. They will get exposure to communication skills and technical presentation from experts through formal session’s and one to one interaction.

Week-4 Consolidation and Finalization

The participants will work on simulations and analysis to mature their project ideas. Expert interaction will continue during this week. They will interact with the MRC advisers and experts to finalize the project ideas.

Week-5 Goa Visit

The participants will get a one week exposure to Goa's rich maritime scientific and industrial base. Goa University, NCAOR and NIO, will provide a one week capsule including field trip to ocean research. Experts and practitioners will interact with the participants to give them a holistic maritime feel.

Week-6 Evaluation and Documentation (in Goa)

The coordinator and the advisers along with some industry experts and senior scientists will evaluate the students for their work. The further opportunities will also be discussed. The participants will be encouraged to document their efforts in the form of a small article or paper. The participants will submit a four page write-up on their efforts to be included in a souvenir.

Underwater Domain Awareness

The concept of Underwater Domain Awareness (UDA) in a more specific sense will translate to our eagerness to know what is happening in the undersea realm of our maritime areas. This keenness for undersea awareness from the security perspective, means defending our Sea Lines of Communication (SLOC), coastal waters and varied maritime assets against the proliferation of submarines and mine capabilities intended to limit the access to the seas and littoral waters. However, just the military requirement may not be the only motivation to generate undersea domain awareness. The earth's undersea geophysical activities have a lot of relevance to the well being of the human kind and monitoring of such activities could provide vital clues to minimize the impact of devastating natural calamities. The commercial activities in the undersea realm need precise inputs on the availability of resources to be able to effectively and efficiently explore and exploit them for economic gains. The regulators on the other hand need to know the pattern of exploitation to manage a sustainable plan. With so much of activities, commercial and military, there is significant impact on the environment. Any conservation initiative needs to precisely estimate the habitat degradation and species vulnerability caused by these activities and assess the ecosystem status. The scientific and the research community need to engage and continuously update our knowledge and access of the multiple aspects of the undersea domain. Fig. 1, presents a comprehensive perspective of the UDA. The underlying requirement for all the stakeholders is to know the developments in the undersea domain, make sense out of these developments and then respond effectively and efficiently to them before they take shape of an event.

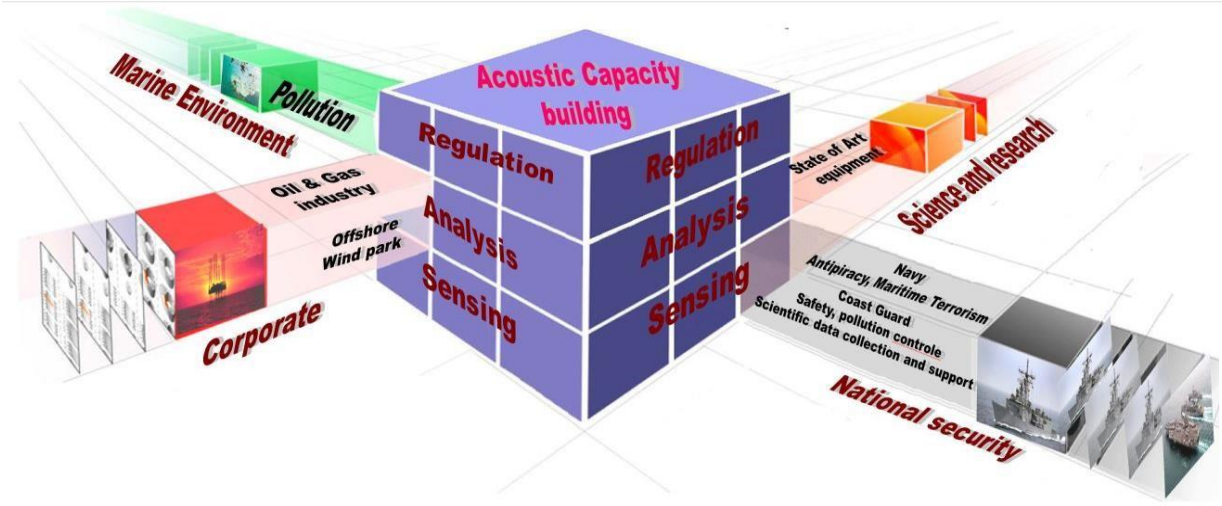


Fig. 1 Comprehensive Perspective of Undersea Domain Awareness

The UDA on a comprehensive scale needs to be understood in its horizontal and vertical construct. The horizontal part would be the resource availability in terms of technology, infrastructure, capability and capacity specific to the stakeholders or otherwise. The vertical part is the hierarchy of establishing a comprehensive UDA. The first level or the ground level would be the sensing of the undersea domain for threats, resources and activities. The second level would be making sense of the data generated to plan security strategies, conservation plans and resource utilization plans. The next level would be to formulate and monitor regulatory framework at the local, national and global level.

.

Detailed Weekly Program

Week-1 (04 – 09 Jun 2018) - Project Identification

Days/Time	0930-1100 hrs	1130-1300 hrs	1400-1530 hrs	1600-1730 hrs
Day-1	Inaugural Event	Administrative Activities	UDA Introduction Dr(Cdr) Arnab Das	Summer School Briefing
Day-2	UDA Workshop on Broad Framework - Dr.(Cdr) Arnab Das		Project Discussion	
Day-3	Three day workshop on Matlab/Python/Data Science Resource Person – Mr. Umesh Gupta IIT Mumbai/National Supercomputing Mission			
Day-4				
Day-5				
Day-6	Pune Darshan – Organized Trip			

Week-2 (11 – 16 Jun 2018) - Interaction with Domain Experts

Days/Time	0930-1100 hrs	1130-1300 hrs	1400-1530 hrs	1600-1730 hrs
Day-1	Project Interaction and Progress Review – Dr.(Cdr) Arnab Das			
Day-2	Two day workshop on Coastal Engineering and Physical Modelling. Resource Person-Dr. T M Perchure.			
Day-3				
Day-4	Communication Skill and Structured Writing – Ms. Scharada Dubey			
Day-5	Workshop by Shri Praful Talera – Geo-politics and the Choke Points in the IOR. Growing Opportunities in the Maritime Sector.		Project Interaction and Progress Review – Dr.(Cdr) Arnab Das	
Day-6	Own Time			
Day-7	Bio-Diversity Walk & Session on Mangrooves and Coastal Environment – Shri Sachin Punekar	Own Time		

Week-3 (18 – 23 Jun 2018) - Interaction with Domain Experts

Days/Time	0930-1100 hrs	1130-1300 hrs	1400-1530 hrs	1600-1730 hrs
Day-1	Invited Speaker – Mr. Chaitanya Giri, Gateway House Mumbai		Project Work on your own	
Day-2	Two day workshop at the Maritime Research Centre – IMF Council Members.			
Day-3				
Day-4	Yoga Session	Interaction with Shri Pradeep Rathi, Founder 3i Zone	Lecture by Dr. Sanjay P Eksambekar, Founder Centre for Advance Study in Microfossils	

Day-5	Project Interaction and Progress Review – Dr.(Cdr) Arnab Das	Lecture by Dr. Shekhar Mandai, Director NCCS	Visit to National Centre for Microbial Research
Day-6	Trek with Shri Praful Talera		Own Time
Day-7	Visit to NDA		Own Time

Week-4 (25 – 30 Jun 2018) - Interaction with Domain Experts

Days/Time	0930-1100 hrs	1130-1300 hrs	1400-1530 hrs	1600-1730 hrs
Day-1	Lecture by Dr. Santosh Vyas, Founder MIDAS Insights.	Project Interaction and Progress Review – Dr.(Cdr) Arnab Das		
Day-2	Project work on their own			
Day-3	Project work on their own			
Day-4	Workshop on Marine Conservation – Challenges and Opportunities. Mr. Murlidharan from Dakshin Foundation.			
Day-5	Project Interaction and Progress Review – Dr.(Cdr) Arnab Das			
Day-6	Departure to Goa			

Week-5 (02 – 07 Jul 2018) – Field Trip

Days/Time	0930-1100 hrs		1130-1330 hrs	1430-1600 hrs	1630-1730 hrs
Day-1	Welcome Address by VC Goa University	Lecture by Director NIO	Lecture by Director NCAOR	Workshop by Dept of Marine Science Faculty at Goa University. Prof. H. B. Menon, Prof. V. M. Matta & Dr. Aftab Can.	
Day-2	"Ocean & Mankind – the invisible link" an interactive session with Dr. Prasanna Kumar.	Marine Biodiversity, Ecosystem function, Climate Change and Anthropogenic Input- Prof. C. U. Rivonker		Visit to the NIO research facilities.	
Day-3	Full day workshop by NIO				
Day-4	Talk on Marine Archaeology – Dr. Rajiv Nigam	Visit to Marine Archaeological Site in Goa-Dr. Loveson			
Day-5	Visit to Indian Coast Guard Station			Visit to Navy Facility NIH	
Day-6	Beach Walk and Exposure to Marine Science-Dr. Prasanna Kumar & Dr. Baban Ingole.				

Week-6 (09 – 13 Jul 2018) - Project Documentation

Days/Time	0900-1100 hrs	1130-1330 hrs	1430-1600 hrs	1630-1800 hrs
Day-1	Half day visit to NCAOR		Visit to Marmagoa Port	
Day-2	Visit to Goa Shipyard		Visit to Marine Industry	
Day-3	Ocean Cruise in two batches. Organized by Dept of Marine Science, Goa University - Dr. S. Upadhyay and Dr. M. R. Nasnodkar.			
Day-4	Project Interaction and Progress Review – Dr(Cdr) Arnab Das			
Day-5	Project presentation to experts		Valedictory Function & Close	

Program Details

Pune Phase

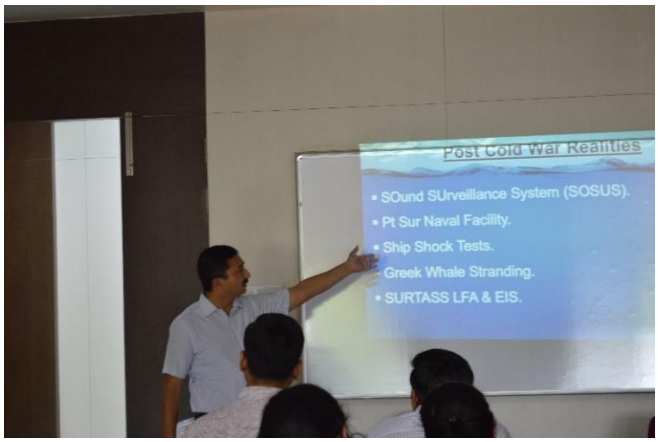
WEEK 1: (04 - 09 Jun 2018)

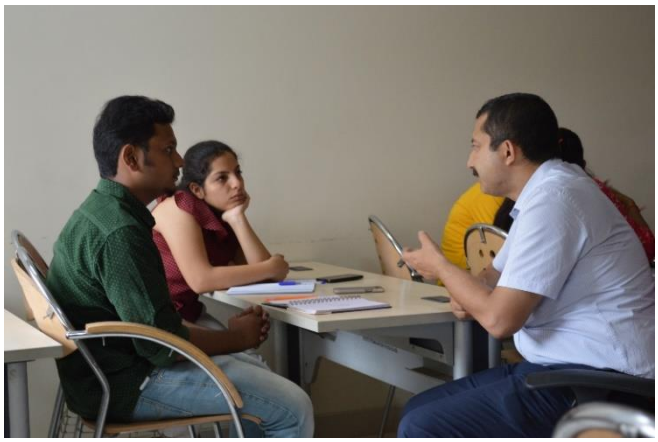
Day 1: Inaugural Event and Introduction to UDA Summer School

The day began with the inaugural event, addressed by, Prof Nitin Kalmalkar: Respected Vice Chancellor of Savitribai Phule Pune University. Prof AD Shaligram: Registrar Pune University. Commodore Rajan Vir (Retd): President IMF (Indian Maritime Foundation). Shri Jayant Sahasrabuddhe: Vijnana Bharti. Shri Praful Talera: MD Dynamic Logistics, MRC Advisor (Blue Economy), Dr (Cdr) Arnab Das, Director MRC and Convener UDA Summer School. The Inauguration Event was followed by a brief Introduction to the UDA Summer School by Dr (Cdr) Arnab Das. Participants were made aware about the objectives of the Summer School.

Day 2: Workshop on UDA framework and Project Identification

The second day of the UDA Summer School was all about clearing basic principles on the broad framework of Underwater Domain Awareness. All the topics that were provided to the students revolved around Geopolitics, Blue Economy, Marine Environment and Ecology, Underwater Acoustics and Robotics and Defence for incorporation of discussions on project based analogy of the same among the participants.





Day 3 Introduction to Data Science, Matlab and Python

The third day started with the commencement of three day workshop on Data Science, Matlab, Anaconda and Python by Mr Umesh Gupta and Mrs Prachi Gupta, from M/S Syncthreads an IIT Mumbai incubated start-up and also part of the National Supercomputing Mission. Since all the participants varied in their domains, the first day of the three day workshop was devoted for basics of data science followed by data handling using python.

Day 4: Application of Python and Hands on

The applications of the H20 and PANDAS were introduced. There was a question answer session on the previous day's introduction to data sciences which was later followed by hands on training with the help of these above mentioned applications. Special care was taken for the students of diverse backgrounds and concepts were explained in the easiest possible mediums. The idea was to help everyone understand the utility of data science and their applications in different fields.

Day 5: Interaction with Experts from MathWorks and Intel.

The final day of the workshop started with a small test, in order to revise the topics covered. This was followed by a lecture on MATLAB application by Mr. Amit Doshi, Senior Application Engineer-Technical Computing from Math Works. The post lunch session was taken by Mr. Seetha, V.P. Intel on Artificial Intelligence and Data Science also a panel discussion was conducted on AI/ML and opportunities created for students by AI were also discussed. The role of Intel into the growing era of AI was touched upon also highlighting the new dimensions which these concepts offer.

Day 6: Pune Darshan - organized trip

Pune Darshan program was organized for all the participants, which was a very different experience for the first timers and the familiar ones. It gave a very important historical and cultural insight along with some facts about the inception of this amazing city. This event was a perfect way to end the week-1.

WEEK 2: *(11 -17 Jun 2018) – Interaction with Domain Experts*

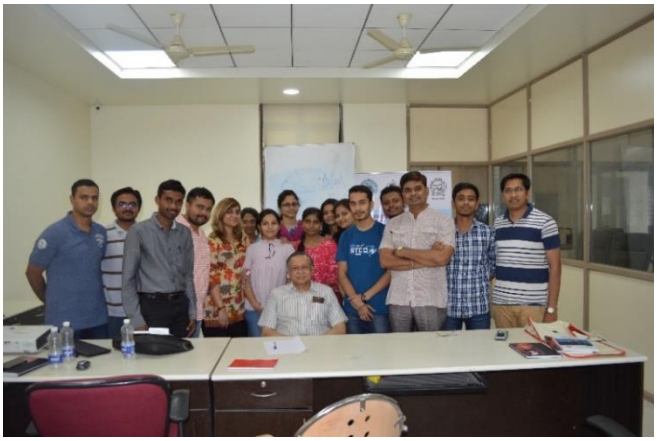
Day 1: Project interaction and Progress review - Dr. (Cdr) Arnab Das

The day was dedicated to refreshing the concept of Underwater Domain Awareness and also studying the other aspects of the same. First half session comprised of useful insights on different aspects of the underwater domain like acoustics, anthropogenic noise/sound. The second half session was directed towards individual project discussions. Valuable inputs were given to individual projects by Dr. Arnab Das.

Day 2 & 3: Coastal Engineering and Physical Modelling Workshop

A two day lecture series was organized where thoughtful insights were provided by respected Dr. T.M. Perchure, on basics of coastal engineering and environmental engineering.

The sessions on day-2, continued with the discussions on Harbor Designing, Inland Navigation, Wave Spectrum, Physical and Mathematical modeling. The discipline is rather an important constituent in the field of marine and ocean studies and demands attention and productive initiative



Day 4: Communication Skill and Structured writing

Since Communication is one of the prime mediums of expression, the participants were exposed to empowering effective communication by Mrs Scharada Dubey, Journalist and Author of many books. The participants learned the importance of effective communication to make them sea-minded on a global mission for saving the environment. Focus was also drawn upon imbibing problem solving attitude in order to formulate better advocacy. Real problem solving in different situations was done by students in groups with representations on paper and by the medium of enacting a play.

Day 5: Geo-politics and the Choke Points in the Indian Ocean Region.

Growing necessity of change has made it but mandatory to learn the ethics behind geo-politics which was showcased in the most facile ways by Mr Praful Talera (MD, Dynamic Logistics & MRC Adviser (Blue Economy)). These important aspects covering world trade and an insight to the world's Choke-points made it easier for the participants to understand how the working of nations using effective diplomacy and geo-strategy work and how the Indian contingent needs to have a thoughtful leadership in order to be self-sustaining.

Day 7: Bio-diversity walk, Session on Mangroves and coastal Environment

A bio-diversity walk was organized on Sunday morning, in the Pune University campus by Dr. Sachin Punekar. The flora and fauna was explained while discussing about the exotic and indigenous species. This was followed by a brief presentation on the flora and fauna of the Western Ghats and benefits of the same for the ecology, its conservation and impact on mankind. Significance of Indian medicinal plants and other species was highlighted.

WEEK 3 *(18-24 Jun 2018) - Interaction with Domain Experts*

Day 1: Interaction with Mr. Chaitanya Giri, Gateway House Mumbai

Dr Chaitanya Giri, Fellow Gateway House Mumbai, gave us conceptualized thoughts about molecular and element analysis being detrimental for developed change with accordance to SPACE AND OCEAN: The common heritage of mankind. Also, the participants were introduced to significance of deep seabed activities and importance of rare earth minerals found in the underwater domain. Basic understanding of space exploration and Comets was also provided.

Day 2: Interaction with IMF Council Members

A visit was organized to the Maritime Research Centre, at the Deccan College. Mr. Yezdi Batliwala, an avid sailor, marine engineer and a council member of Indian Maritime Foundation, shared some valuable information and experiences regarding the oceans. Capt. Anand Dixit, a Governing Council member of the MRC guided the students on multiple aspects of the oceans. Post lunch sessions were dedicated to individual project discussions.

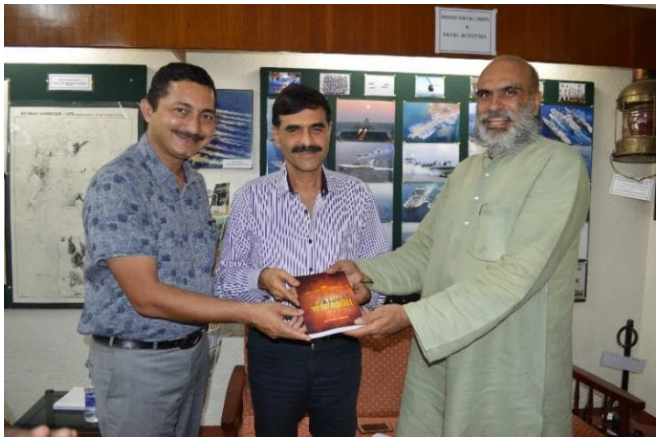





Day 3: *Expert talk on Water at Maritime Research Center*

On day two of the MRC workshop, a tour was conducted in the Maritime Museum, by Cmde Rajan Vir, President; Indian Maritime Foundation. Post lunch session, consisted of a very interesting talk by Dr.Vishwas Yevale on 'water' and its multiple facets, joined in by Shri Praful Talera.



Day 4: International Yoga Day Activity, expert speech on Startup & Innovation and Phytoliths.

On the occasion of International Yoga Day, a yoga session was organized in the morning. Mr. Pramod Khandekar, guided us through a rejuvenating yoga session and explaining its benefits for body and soul.

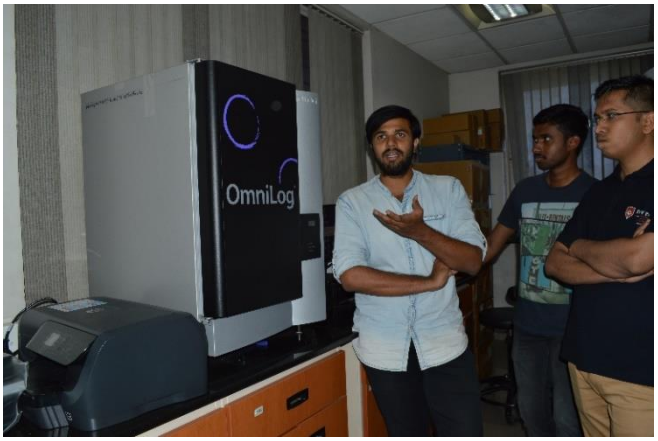

A very unique session on startups and innovations was upheld by Mr. Pradeep Rathi, a pioneer in the field. The session focused on innovations and ensuring their longevity. The art of structuring innovations and the important factor of creativity and the variables affecting the same were highlighted. A very detailed understanding of organization, its role and how to effectively motivate and run the process was explained. The takeaway was – innovation with creativity and delivery.

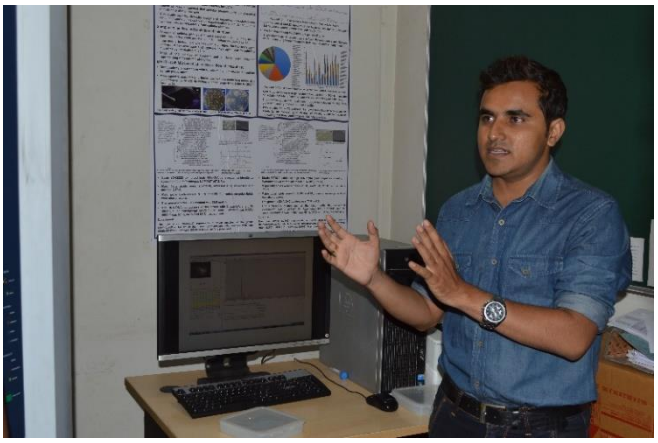
Post lunch session was delivered by Mr. Sanjay Eksambekar, a Bio- Archaeologist specializing in Phytoliths of the Phytolith Research Institute; Centre for Advance Research in Microscopic Plant Silica, Pune, which is one of its kinds. The session was distinctive in nature and provided a new insight as the field is in its nascent stage but is of a rather important nature as it enhances our understanding of the man and ecology relationship, climatic changes and its impact.

Day 5 : Session on Biotechnology and visit to NCMR Lab.

A lecture on Biotechnology and its Applications was delivered by Dr. Shekhar C Mandai, Director, National Centre for Cell Science (NCCS) Pune. An introduction to biological material and related technology was given. Biotechnology has various useful applications in different areas like Health, prevention of diseases, agriculture etc. The aspect of genetic modifications of certain plant species was discussed, following the benefits of the same to mankind.

In the second half, a visit to the National Centre for Microbial Research, NCMR was facilitated. The labs were visited along with information on cell sciences and the equipment's required for the same.





Day 6: Trek with Shri Praful Talera

The weekend set in and an early morning trek was organized by Shri Praful Talera to a nearby hillock. The morning freshness was an enchanting experience, along with the necessary exercise contributing significantly for team building.

Day 7: Visit to National Defence Academy

Sunday was dedicated to a motivational visit to NDA, a rare opportunity. It provided the participants a glimpse of the Indian Forces, its history along with the tough regime of the cadets who never get tired!

1

WEEK 4 *(25- 30 Jun 2018) - Interaction with Domain Experts*

Day 1: Lecture by Dr. Santosh Vyas, Founder MIDAS Insights

It was an honor to have Dr. Santosh Vyas as a speaker for a half-day session. He has a background of Biotechnology and MBA and is known for startups and innovations. He spoke about the plethora of avenues that the oceans hold for us, from being a rich protein source to major contributors in the beauty industry. He also shed light on aquaculture, its nascent stage in India and its implications.

Day 2 and Day 3: Project Interaction and Progress Review – Dr (Cdr) Arnab Das

Day 4: Workshop on Marine Conservation by Mr. Muralidharan from Dakshin Foundation

A full day workshop was organized on Marine Ecology and its conservation. Dr. Murlidharan, from Dakshin Foundation, Bangalore gave useful insights on the importance of marine biodiversity and how it affects the ecology with the help of case studies. The Fishery Industry, which is a major food source, has its own regional challenges which were showcased with the help of documentaries.

Day 5 : Valedictory Event at IUCCA, University Campus

An informal interaction with respected Shri Jayant Sahasrabuddhe was held, where he shared some thoughtful ideologies and experiences. Post lunch, a visit to the IUCAA campus was organized which enabled understanding physics in the simplest forms.




Evening session held an important event to mark the closing of the Pune phase. The event was graced by the presence of Dr. Samak RoyChoudhury-Director IUCAA, Shri Jayant D Patil- Head of L&T Defence, Lt Gen D B Shekatkar (Retd)- Defence Analyst & President FINS, Cdr D Bhatnagar (Retd) CEO Mahindra Defence Naval Systems, Cmde Rajan Vir (Retd) – President IMF, Dr. Arvind Shaligram – Registrar SPPU, Mr. Harshvardhan Gune-GM Worldwide Oilfield Machines, Shri Ketan Shah-Trustee MRC, Vice Admiral Pradeep Chauhan- Director NMF. This was followed by personal interactions between the dignitaries and the guests over high tea.

Pune Phase

WEEK 5: *(02- 07 Jul 2018) – Interaction with Experts and Field Visit*
Day 1: Inaugural event at Goa University

Inauguration at the Goa University, and the commencement of the Goa phase of UDA took place in the presence of Prof M.K Janardhan Officiating VC Goa University, Dr.Prasanna Kumar Former Director NIO, Prof. CU Rivonkar, HOD Marine Science Dept.(Goa University), Shri Suhas Godse and Dr. Arnab Das. This was followed by a small presentation by Dr Arnab Das which described UDA summer school, it's objectives and the Pune Phase. Prof M.K Janardhan shared his experience in Maritime Domain and his agreement to the fact raised by Arnab Das on the negligence of Underwater Domain Awareness. Prof Rivonkar spoke about Impact of marine processes on the ecosystem functions.

Post lunch sessions were hosted at the Marine Science Department, Goa University. The sessions were based on topics like Remote Sensing: A tool for Coastal Surveillance by Prof H. R. Menon followed by Mining and its Effect on Trace Metal Contamination on the waters of the Zuari Estuary by Prof. V. M. Matta and lastly Relation between Oceanography and Climate change by Dr. Aftab Khan.




Day 2: Ocean and Mankind Interactive Session with Dr. Prasanna Kumar and visit to NIO research facilities.

The day began with an interactive session by Dr. Prasanna Kumar, Former Director NIO, on the Oceans and its relationship with Mankind. This was followed by a very informative lecture by Dr. Baban Ingole, Senior Scientist, NIO on Benthic Ecology and its Biodiversity.


Post lunch sessions were followed by a visit to the NIO labs, which are equipped with high end machines and equipment's to compliment scientific researches related to all aspects of Marine domain.




Day 3: Full day workshop at NIO with various domain experts

The schedule for day three in the Goa phase was dedicated to various sessions from the scientists working on some major aspects at NIO. The day started with lecture on Understanding Climate Change- 'Close from the past' by Dr.Rajeev Saraswat. It was followed by a talk on Ocean Biotechnology, an emerging area of interest on a global level by Dr. Sameer Dhamle Chief Scientist NIO.


Dr Saha delivered a lecture on Marine Litter and Micro-plastics in Ocean, an informative talk was given on importance of Metal specification study in Marine System by Dr.Parth Sarthi Chakraborty


Dr. M. Balakrishnan addressed the participants on Coral Reefs and Climate Change followed by an introduction to Water Waves and Coastal Processes by Dr. Mandal.


The second last session of the day was given by Dr.Biswajeet Chakraborty. We ended our day by a beautiful lecture given by Dr. Hemanti Biswas on the Perturbed Bio-geochemical cycles in the Anthropocene.


Day 4: Session on Marine Archeology and Visit to Archeological sites.

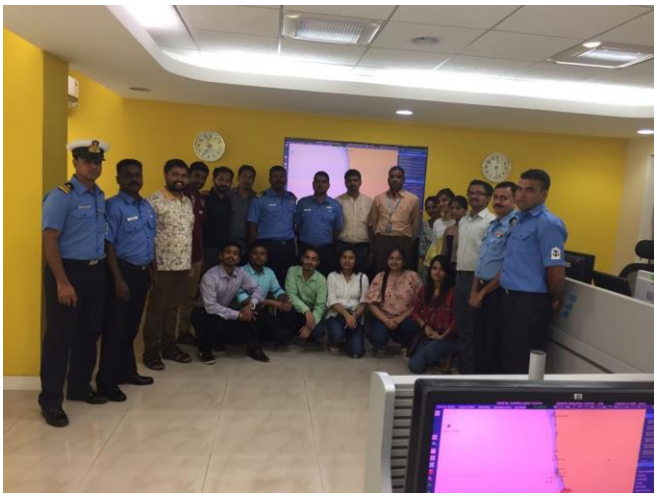
The third and the last day at NIO was dedicated to Marine Archaelogy. Dr V. J Loveson enlightened the crowd by delivering a talk on Remote Sensing in Marine Archaeological Studies. The other half of Marine Archaeology i.e Marine Heritage which includes role of sea level fluctuations in shaping the destiny of the ancient Indian Coastal Cities was briefed by Dr. Rajiv Nigam, Senior Scientist NIO.

We had a visit to Marine Archaeological collections in NIO under the guidance of Dr. V. J Loveson. All the Ancient Marine Archaeological Artifacts were displayed and the history was explained.

Post lunch, a field trip was organized to Gopikapattinam, we got a unique opportunity to see how Ground Penetrating Radar (One of the rarest machinery in the Nation) works.

Day 5 : Visit to Indian Coast Guard Station and National Institute of Hydrography

A visit to a Coast Guard patrol vessels was organized. Information on different controls of the ship was provided by officials and the engines were explained by the Engineering Officer on board. The next visit was to the Coast Guard Headquarters where a warm welcome was complimented by a brief presentation on the Coast Guard, its inception and its duties which were followed by one on one interaction with the District Commander followed by high tea.



Post lunch, a visit was organized to the National Institute of Hydrography, the only interaction with Navy. A brief presentation made us familiar with the organization, while the guided tour through the campus enlightened us on a new discipline.

Day 6 : Beach walk and exposure to Marine Science.

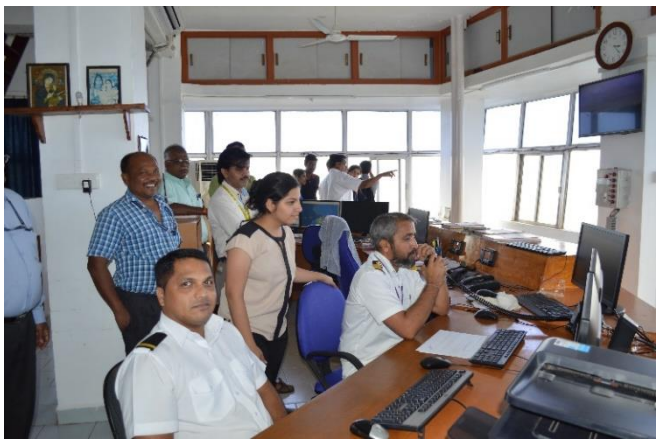
A beach walk was organized with Dr.Prasanna and Dr. Baban Ingole. The day encompassed a walk through different types of beaches like Miramer, Arambol, Baga and Calangute. The concepts of Marine biodiversity were explained by Dr. Baban, while the physics behind the waves was covered by Dr. Prasanna. It was an enriching experience cum recreation.

WEEK 6: *(09- 14 Jul 2018) - Field trip and Project Documentation*

Day 1: Visit to National Centre for Antarctic and Ocean Research & Marmagao Port Trust

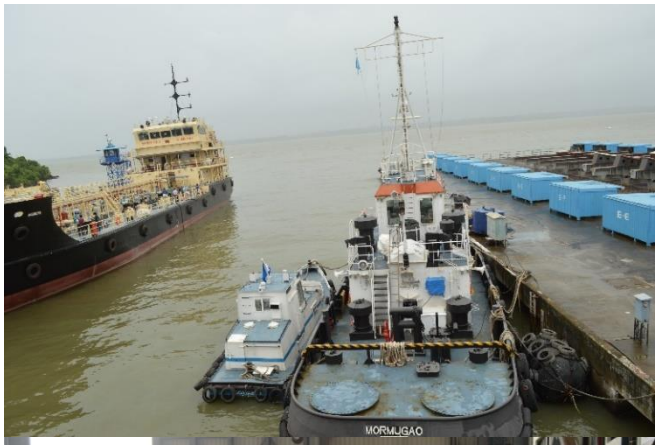
The morning session began with a visit to National Centre for Antarctic and Ocean Research (NCAOR). A brief about the working of NCAOR was given by Dr. Thamban Maloth, Group Director (Polar Sciences). Further, the session was graced by various scientists who spoke about the research carried out in the Antarctic region, the challenges faced and the opportunities through a comprehensive presentation. This was followed by a visit to their labs, where the samples collected are processed, which were at -5, -15 and -20 degrees C, respectively which gave us a clear idea about the significance of polar research.

Post lunch, a visit was organized to Marmagoa Port Trust, where the highly confidential and nuanced process of Vessel Traffic Control was explained. A tour around the port was provided by officers from the port trust that gave us an insight of different functions of a port.



Day 2: Visit to GOA Shipyard and Kineco Kaman

The day commenced with the visit to the Goa Shipyard, which was a unique opportunity to see big ships being manufactured. The interesting part was to be able to witness the ship being lifted from water and into the yard.



The next visit was to Kineco Kaman, a joint venture between Kineco Group of India and Kaman Aerospace of the US, primarily dealing in composites.

Day 3 : Ocean Cruise & Hands On Data Collection

An unforgettable hands-on experience was organized in the form of an ocean cruise, for demonstration of data collection. This was done with the aegis of the Marine department of Goa University. The group was divided into two batches and experiments like Water Sampling, Sediment Sampling, Water Temperature Measurement, Zooplankton and Phytoplankton collection etc., was demonstrated.

Day 4 : UDA Program Valedictory

The valedictory of UDA program took place in the NIO campus, in the presence of Prof. Sunil Kumar Singh, NIO Director, Dr. Baban Ingole, Former Scientist NIO, Shri Jayant Sahasrabuddhe, National Organizing Secretary Vijanana Bharati, Shri Ashish Shah, National Treasurer Vijnana Bharati and Shri Praful Talera and Shri Ketan Shah.

The session started with an insight into activities and achievements of NIO, provided by Prof. Sunil Kumar Singh. Following the Director NIO's address, both participants as well as Dignitaries shared their experience and provided feedback on the UDA Summer School. The session ended in a positive note with a vote of thanks provided by Shri Suhas Godse.

Day 5 : Project Presentation and Interaction with Shri Manohar Parrikar, Honourable Chief Minister of Goa and Former Defence Minister.

There could not have been better ending to such a wonderful journey. The participants got the opportunity to present their projects to Dr. Prasanna Kumar, Former Director NIO, Dr. Baban Ingole, Former Scientist at NIO, Shri Jayant Sahasrabudhhe, National Organizing Secretary, Vijnana Bharati, Shri Praful Talera, Industrialist & MRC Adviser (Blue Economy), Shri Ketan Shah, Enlightened Citizen and MRC Trustee and Shri Ashish Shah, Treasurer Vijnana Bharti.

It was a learning experience to meet the Hon. Chief Minister of Goa and Former Defence Minister Shri. Manohar Parrikar Sir. The agreement by our leaders to the fact that Underwater Domain is very much in its infancy, with only a handful of people engaged in the safe, secure and sustainable growth of Indian maritime domain is itself an indication for the youth of the nation to look forward to put further efforts into this area.

List of Participants

Sr.No	Name	Position	Stream	College
1	Amarjyoti Kumar	B.Tech 3rd Year	Electronics & Telecommunication	Assam Don Bosco University, Guwahati
2	Ilakshi Deka	B.Tech 3rd Year	Electronics & Telecommunication	Assam Don Bosco University, Guwahati
3	Nisha Kalita	B.Tech 3rd Year	Electronics & Telecommunication	Assam Don Bosco University, Guwahati
4	Rohan Kumar Boruah	B.Tech 3rd Year	Electronics & Telecommunication	Assam Don Bosco University, Guwahati
5	Ushmita Deka	B.Tech 3rd Year	Electronics & Telecommunication	Assam Don Bosco University, Guwahati
6	Karan Krishna Bhat	M.Tech 2nd Year	Signal Processing and Communication	Defence Institute of Advanced Technology, Pune
7	Ankit Biswas	B.Tech 3rd Year	Computer Science	G.H Raisoni College of Engineering, Nagpur
8	Dimple Khilwani	B.Tech 3rd Year	Computer Science	G.H Raisoni College of Engineering, Nagpur
9	Aditi Subhashrao Pawane	B.Tech 4th Year	Electronics and Telecommunication	MGM College, Nanded
10	Jayashree Deka	PhD Scholar	Electrical and Electronics	Assam Don Bosco University, Guwahati
11	Divya Nagarajan	M.Sc 2nd Year	Microbiology	Modern College, Pune
12	Pankaj Sawdatkar	M.Tech 2nd Year	Mehanical and Materials Technology	Savitribai Phule Pune University, Pune
13	Jaswantsing Rajput	PhD Scholar	Signal Processing	BATU, Lonere
14	Digambar Puri	PhD Scholar	Signal Processing	BATU, Lonere
15	Sai Pradeep Akey	Assistant Manager	-	Garden Reach Shipbuilders & Engineers Ltd, Kolkata
16	Dy Comdt C.B Shaik	Deputy Commandant	-	ICGS AMAL, Indian Coast Guard, Goa

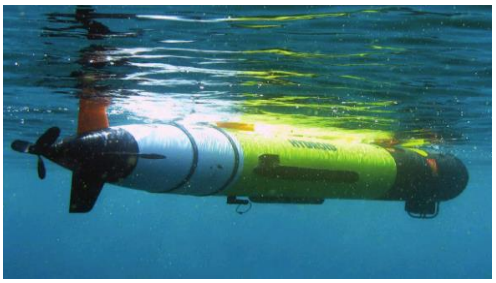
Project Summary

UNDERWATER DRONE AND THEIR APPLICATIONS IN THE INDIAN OCEAN REGION (IOR)

Aditi Pawane

The Oceans are a hostile environment and gathering information on deep-sea life and the seabed is incredibly challenging. Autonomous underwater vehicles are robot submarines that are revolutionizing the way in which researchers and industry obtain data. Advancement in technology has resulted in capable vehicles that have made new discoveries on how the oceans work and have dramatically reduced the cost to industry of surveying the seabed. Autonomous Underwater vehicles can be used to study the abundance of fish shoals, availability of minerals and discovering petroleum products. However till present date UAV's are used in limited fields. There is tremendous scope for further innovation beyond the topics discussed, and this will help the next generation of engineers and scientists in academia, industry and government laboratories, to deliver those advances. In the last two decades AUV were transformed from heavy and expensive equipment for ocean academic research into a tool for solving a wide range of issues in many theoretical and practical fields including commercial and military fields.

India's 2.0134 million square km EEZ provide great opportunity to explore the ocean and utilize its resources wisely. Today we require sophisticated tools and equipment which can facilitate our work and provide us better and efficient opportunities to explore the ocean. There are numerous methods to explore the ocean, amongst them underwater drone is an upcoming disruptive technology which can ease our work and can provide us high resolution data. Use of underwater drones is common in other developed nation but in India yet the innovation has to go a long way. Now the time has come to adopt to the this technology. Fig shows an AUV.



The underwater vehicles available today include human occupied submersibles, Remotely Operated Vehicles (ROV), Autonomous Underwater Vehicles(AUV) and towed robots. The ROV are tele-operated robots that are always tethered to the mother ships and that are always tethered to the mother ship and receives power and control signals. Autonomous Underwater Vehicle (AUV) is an autonomous and unthreaded. The AUVs have an acoustic link with the control ship or other mooring platforms for occasional communication and travels underwater along the preprogram route by the operator.AUVs are quickly becoming popular among marine science communities due to its data gathering capabilities.

Many countries across the word have enhanced AUV capabilities by incorporating the advanced technologies available in the market like Battery technology, Electrical parts design, Mechanical parts design, Hull design, Development in Engine designand Efficient Propulsion

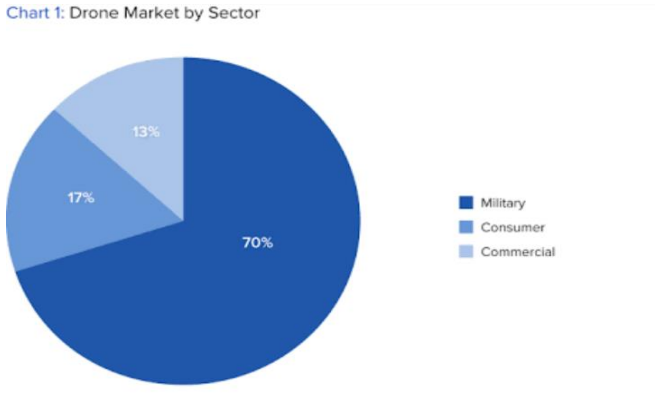
system, Advanced communication equipment, better visual capabilities, Improved Sonar capabilities, Efficient Hydrodynamics, Improved Navigational equipment. Further innovation of material technologies like composites and carbon fiber made these AUVs more robust, less corrosive and lightweight due to which the fuel efficiency and endurance of the AUVs have increased.

Until recently, AUV's have been used for a limited number of tasks dictated by the technology available. With the development of more advanced processing capabilities and high yield power supplies, AUV's are now being used for numerous tasks with roles. Modern AUVs are being used in commercial, military and research.

(a) Commercial: The oil and gas industry uses AUVs to mark detailed map of the seafloor before they start building subsea infrastructure. Pipelines and subsea completions can be installed in the most cost effective manner with minimum disruption to the environment. The AUV allow survey companies to conduct precise surveys of areas where traditional bathymetric surveys would be less effective or too costly. AUV systems may contribute inspection of oil-and gas-producing companies subsea assets, where they will lead to earlier detection of problems. This will lead to a reduction in downtime for field maintenance, and of course better stewardship of the environment

(b) Military: A Typical military mission for an AUV is to map an area to determine if there are any mines or to monitor a protected area for new unidentified objects. AUVs are also employed in anti-submarine warfare, to aid in the detection of manned submarines.

(c) Research: Scientists use AUVs to study lakes, the ocean, and the ocean floor. A variety of sensors can be affixed to AUVs to measure the concentration of various elements or compounds, the absorption or reflection of light and the presence of microscopic life. Following Pi-diagram shows percentage wise utility of AUVs.



Various countries like USA, China, Russia, Japan, and Singapore are already using underwater drone in various field. However, India as a nation has to emerge in the field of underwater drone. Indian need to focus on using new materials, new AUV design concepts, new propulsion systems, batteries with high capacitance, Increasing AUV application in military, AUV miniaturization and increase their computational capability, Reducing AUV cost, Reducing the Cost, Increasing Efficiency, Using neural networks and artificial intelligence, and increasing AUV application for working in groups. Underwater robotics represents a fast growing research area and potential application area which is unexplored in India.

EVOLUTION OF MAPPING AND TRACKING SYSTEMS OF MIGRANTS IN INDIA OCEAN REGION

Ankit Biswas

The subsequent rise in human efficiency has led to a gradual increase in human population especially in most south Asian countries. This sudden rise in population has led to creation of many problems such as increased utilization of resources and lack of living space. These problems in turn contribute to be mass exodus of people from one point to another. Migration is a result of this situation. But the problem here does not lies in migration but the migrants. These migrant may come for a safe haven but along with innocent lives they bring about various syndicates and traffickers waiting to exploit them. Therefore it is necessary to properly and modestly track and map the trails of these migrants to safeguard both them and their new home from these evils of man.

To be able to track these migrants we require a system capable enough to store huge amounts of data along with constantly train and modify its tracking pattern to suit modern needs. Tracking by nature is dynamic henceforth it requires continuous study of the attributes of the tracked entity. But another question arises that how these migrants could be tracked. To solve this problem we need to understand the methods by which migrants travel as well as various improvisations these people have made. Also a concise study of various cases needs to be done for pinpointing our search. After this study we are able to pick out certain patterns within their movement. The data related to these attributes can be used as raw data for the proposed tracking and mapping system. This data requires be constantly updating and modifying to meet up the demands of dynamic binding. The data so obtained will be then used to train mathematical model and prepare the data for analytics and prediction. The first process includes simultaneous retrieving of data from various resource points. After these data are collected they are sorted via query software. This sorted data can now be used by database management system for its analytics and analysis. Analytics can be achieved by using modern day analytics software that can handle data up to ten terabytes. The commonly used formal script in here is Python. Python is selected as the programming language because of its ease of writing as well as being a versatile language that can be implemented in various modules.

Organizations may apply analytics to business data to describe, predict, and improve business performance. Specifically, areas within analytics include predictive analytics, prescriptive analytics, enterprise decision management, descriptive analytics, cognitive analytics, Big Data Analytics, retail analytics, store assortment and stock-keeping unit optimization, marketing optimization and marketing mix modeling, web analytics, call analytics, speech analytics, sales force sizing and optimization, price and promotion modeling, predictive science, credit risk analysis, and fraud analytics. Since analytics can require extensive computation (see big data), the algorithms and software used for analytics harness the most current methods in computer science, statistics, and mathematics

There are myriads of tracking systems. Some are 'lag time' indicators, that is, the data is collected after an item has passed a point for example a bar code or choke point or gate. Others are 'real-time' or 'near real-time' like Global Positioning Systems (GPS) depending on how

often the data is refreshed. There are bar-code systems which require a person to scan items and automatic identification (RFID auto-id). For the most part, the tracking worlds are composed of discrete hardware and software systems for different applications. That is, bar-code systems are separate from Electronic Product Code (EPC) systems, GPS systems are separate from active real time locating systems or RTLS for example, a passive RFID system would be used in a warehouse to scan the boxes as they are loaded on a truck - then the truck itself is tracked on a different system using GPS with its own features and software.

Presently our whole backbone of operations relies upon AIS. The automatic identification system (AIS) is an automatic tracking system used on ships and by vessel traffic services (VTS). When satellites are used to detect AIS signatures, the term *Satellite-AIS* (S-AIS) is used. AIS information supplements marine radar, which continues to be the primary method of collision avoidance for water transport.

Information provided by AIS equipment, such as unique identification, position, course, and speed, can be displayed on a screen or an ECDIS. AIS is intended to assist a vessel's officers and allow maritime authorities to track and monitor vessel movements. AIS integrate a standardized VHF transceiver with a positioning system such as a GPS receiver, with other electronic navigation sensors, such as a gyrocompass or rate of turn indicator. Vessels fitted with AIS transceivers can be tracked by AIS base stations located along coast lines or, when out of range of terrestrial networks, through a growing number of satellites that are fitted with special AIS receivers which are capable of deconflicting a large number of signatures.

The International Maritime Organization's International Convention for the Safety of Life at Sea requires AIS to be fitted aboard international voyaging ships with 300 or more gross tonnage (GT), and all passenger ships regardless of size.

By the successful implementation of these methods and the consequent amalgation of artificial intelligence within this system we can reduce the human errors and amplify our maritime border security. The automation in the system allows defense personnel to deploy more people efficiently and effectively. The dynamic nature of data store also implies that security and intelligence agencies will be able to develop better load outs and enhanced surveillance capabilities. With the development of this system we also hope that the law jurisdiction in our economic zone and outside it will justify its purpose. The fruitful development of our maritime sector depends upon it.

IMPACT OF ANTHROPOGENIC NOISE ON MARINE MICROFLORA

Divya Nagarajan

The ocean supports an incredible variety of Life. It provides a significant source of oxygen for our planet and is instrumental in the capture and storage of carbon dioxide. Looking at the ecosystem in terms of the goods and services they provide, allows us to realize their full value and our dependence on that system in the broadest sense. Marine ecosystem provides important services such as the provision of food, medicines and livelihoods. Unfortunately the resources of the sea have been over-harvested by humans threatening marine biodiversity. Human activities are responsible for a major decline of the world's biological diversity. Underwater Noise levels in the open ocean have been rising since at least the 1960s. As a result, there is a current growing concern that anthropogenic sounds in the marine environment potentially are a substantial impact on marine life. The human contribution to ambient noise in the ocean is believed to have dramatically increased over the past 50 years. Noise has the potential to mask important acoustics cues in marine mammal habitats, such as echolocation and communication and may disrupt prey, affecting foraging. These large-scale changes in the acoustics environment are of particular concern as they have the potential to impact the marine life.

Currently the impact of this anthropogenic noise on the Primary Producers of the ocean ecosystem, 'the phytoplankton' is also being studied. This Phytoplankton plays a vital role in forming the foundation of the marine ecosystem. They are the photosynthetic portion of plankton life. Plankton is the tiny drifting organisms that live in the top layers of ocean and lakes. Because phytoplankton relies on sunlight to produce their own food, they are found in the top layer of water bodies (up to 200meters). They are responsible for half of the photosynthetic activity on the planet, making them important to both their local and global ecosystems. Their importance in carbon-dioxide sequestration has made them a target for controlling carbon dioxide in the atmosphere. As photosynthetic organisms, they are able to convert solar energy into chemical energy. This means that of the carbon dioxide in the atmosphere that gets fixed into sugars, phytoplankton's are doing half of the work. This makes them important to global carbon-dioxide levels. However, phytoplankton contributes to more than 90 per cent of total marine production.

Phytoplanktons include diatoms, dinoflagellates, green algae, cyanobacteria and coccolithophores. Phytoplankton distribution and abundance are influenced by several factors, thus they vary both seasonally and spatially. Primarily, phytoplankton depends on carbon dioxide, sunlight and nutrients for growth, but some other factors such as water depth, water temperature, wind and grazers also play a significant role. Apart from these factors anthropogenic noise produced also effect phytoplanktons, their growth cycles are hampered by increasing noise levels. This contribution is dominated by low-frequency sound (LFS–sounds at frequencies less than 1000Hz), primarily emanating from shipping, oil and gas development, defence-related activities and research. Hence, detailed study of increasing noise level needs to be done, wherein effect of noise on phytoplankton's can be understood and measures to protect the primary producer's could be taken.

This phytoplankton’s being denser than water, retain themselves at the surface to obtain sunlight they tend to produce bubbles in the gas vacuoles. This helps them to retain themselves at the surface and to utilize the sunlight effectively for photosynthesis. These gas vacuoles vary depending on the geographic location and the type of the species involved. These gas vacuoles have a tendency to resonate at a particular frequency. But the increasing anthropogenic noise has shown to disturb the natural resonance frequency of these gas vacuoles, as a result indicating the possibility of disruption of these bubbles. Though this is currently not investigated much they do pose a threat in future as they show a tendency to destroy the basic layer of marine life the 'primary produces.'

Hence much investigation needs to be done in order to understand the effects of these noise and to protect the marine habitat. The problem faced by society is that many economically important activities are at risk because of lack of awareness about the effects of anthropogenic sound on marine life. Effective management of ocean noise pollution necessitates the evaluation of sound source separately followed by the application of appropriate mitigation measures. To achieve this, the initiation of research on the negative impacts of noise on marine life is required, while implementation of existing as well as development of new, effective mitigation measures is necessary.

Exploitation of the environment for one purpose can alter the environment’s ability to provide other goods and services, so this knowledge is also a way of understanding what we stand to gain and lose by exploitation of certain aspects of the environment. In some parts of the world the next two decades will probably see increasing levels of offshore industrial development and this will almost certainly lead to increased amounts of noise pollution in the oceans. Efforts are underway to develop a framework to predict such population consequences of acoustic distribution. Now that the effects of over-fishing, ocean acidification and climate change are better understood, it is critical that marine species are protected to secure their survival and maintain the ecosystem services they provide.

IMPACT OF OIL AND GAS INDUSTRY ON THE ACOUSTIC HABITAT OF RIVER BRAHMAPUTRA

Rohan Kumar Boruah

Assam is a state in Northeast India, situated south of the eastern Himalayas along the Brahmaputra and Barak River valleys. Assam covers an area of 78,438 km^2 (30,285 sq mi). The state shares its boundaries with Bhutan and the state of Arunachal Pradesh to the north; Nagaland and Manipur to the east; Meghalaya, Tripura, Mizoram and Bangladesh to the south; and West Bengal to the west.

The mighty Brahmaputra is the ninth largest river in the world by discharge and the 15th longest. The meandering river originated in the Mansarovar Lake and emptying into the Bay of Bengal, while flowing through Assam valley. Its length is about 891km along the heart of Assam.

Fig: Map of Assam and its neighboring states

The Ganges River Dolphin or Susu, inhabits the Mighty Brahmaputra. They are one of the four "obligate" freshwater Dolphins. It is known as Susu, because of the sound it produces in the time of breathing. The movements follow a seasonal pattern. Most importantly they are the blind species they use the sound for their breathing, searching for the food, and for communication. Its maximum size is 2.67m (females) and 2.12m (male).

Industrial explorations of Gas and Oil have the potential to scroll up the economy of a nation to a greater height. Oil resources are depleting day by day so it is the peak time to explore our own resources. In the regard, Assam is one of the hubs of Oil and Natural Gas.

Government is investing a lot of money for the exploration of our own oil and gas resources in both terrestrial and in underwater resign. In Assam ONGC and Indian Oil have surveyed and located different place of Assam along with different locations in Brahmaputra River. They have decided to start the exploration processes in a place near Dibrugarh known as Khagorijan from October 2018 and many of such will be started soon.

Among the various ill effects of oil and gas exploration in underwater, anthropogenic noise is also found to be causing significant affects on the marine habitats which were neglected till the

last decade. So it's time for us to consider the bad affects of anthropogenic noise in oil and gas exploration.

The underwater noise generated by the different activities during the exploration of oil. The different activities include the seismic survey, drilling, piling, transportation etc. This issue of Noise Pollution is given a concern eye by European countries, and most importantly by IMO (International Maritime Organization), OSPAR, **OGP/IAGC etc.**

In India the Maritime Research Centre (MRC) through its UDA summer school program is trying to make Younger generation of India aware of our maritime potential and its opportunities.

The brief summary of the oil exploration is mentioned below with some of the results given by different organizations.

Oil and gas explorers use seismic survey to produce detailed image of the various rock types and their location beneath the Earth's surface and they use this information to determine the location and size of oil and gas reservoirs. Sound waves are bounced off underground rocks formations and the waves that reflect back to the surface are captured by recording sensors. While surveying large amount of noise are generated that affects the marine species and changes their habitats.

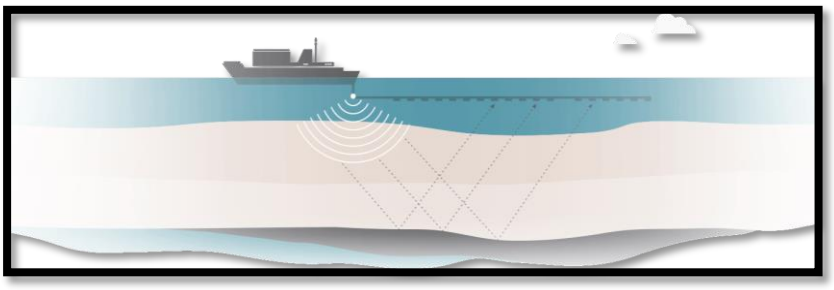


Fig: Showing the Seismic Survey

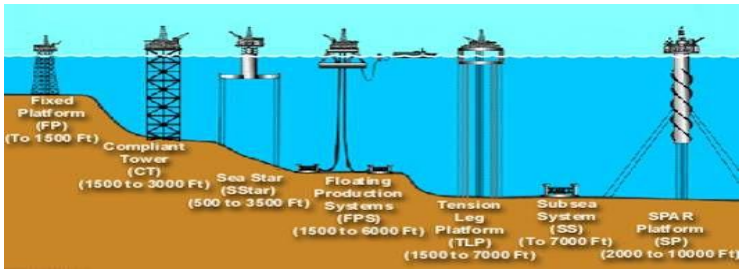


Fig: Different methods of drilling for various depths

Underwater drilling is one of the major sources of noise pollution. Different techniques are used for the drilling purpose. They are shown in the figure below.

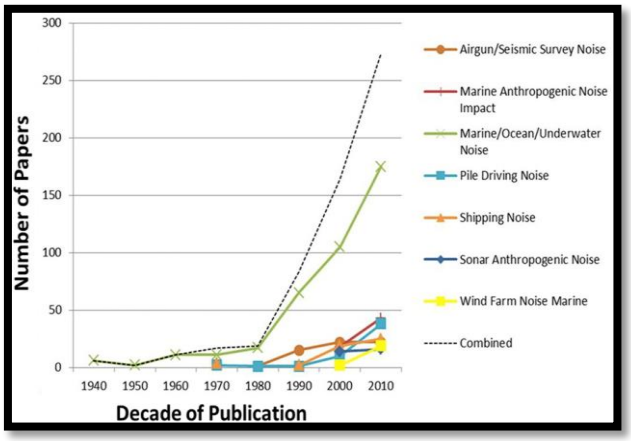
The loss of sound transmission while drilling follows pattern of cylindrical spreading. Sound levels, especially at the lower frequencies, were lower at shallower depths. There was no difference in the sound radiated in the different directions from the rig. One such record of the drilling noise was recorded at a drilling site (Chinampas 6-37) in the Bay of Fundy. The site was located about 5 mi (9 km) east of the Wolves Islands at. It is a semisubmersible marine drilling unit constructed in a triangular plan form.

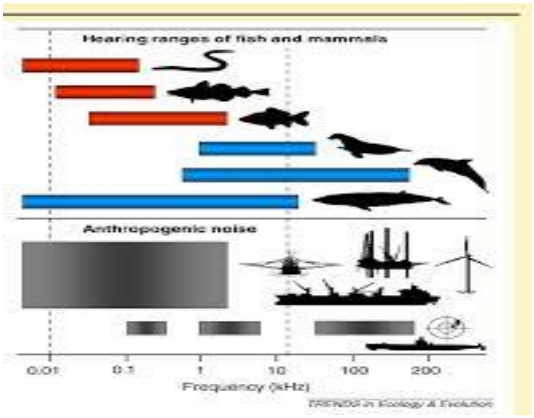
According to Australian piling Guidelines piling noise varies with the size of the pile being installed and the pile driving method used. The most common pile driving methods include impact pile driving, where a pile is hammered into the ground by a hydraulic ram, and vibro-driving, where rotating eccentric weights create an alternating force on the pile, vibrating it into the ground.

Impact piling – Impulsive in character with multiple pulses occurring at blow rates in the order of 30 to 60 impacts per minute. Typical source levels range from SEL 170–225 dB re 1 µPa2 ·s for a single pulse, and peak level 190–245 dB re 1 µPa. Most of the sound energy usually occurs at lower frequencies between 100 Hz and 1 kHz. Factors that influence the source level include the size, shape, length and material of the pile, the weight and drop height of the hammer, and the seabed material and depth.

Vibro-driving – Continuous in character and usually of a much lower level than impact piling. Typical source levels range from SPL 160–200 dB re 1 µPa, with most of the sound energy occurring between 100 Hz and 2 kHz. Strong tones at the driving frequency and associated harmonics may occur with the driving frequency typically ranging between 10 and 60 Hz. Sound propagation at such low frequencies is often poor in shallow water environments, such that the tones may not be noticeable at greater distances from the source.

The graph will give a glance of how the underwater noise has increased in the last decade.





How the anthropogenic noise frequencies are affecting the marine animals that can be very much clear by looking the frequency graph.

We adopt different steps to minimize the impacts one such is avoiding the survey during the period of fish breading or find an area where the population fishes are comparatively less. There may be certain region because of which we can we may not be able to stop the survey for a particular period of time; in this regard we can use the low intensity seismic survey equipments. It is always better to select the drilling platform which produces less amount of noise.

This summary is generalized because underwater oil and gas exploration in Assam has not started yet and maybe by comparing some of results from other works that has been done in other parts of the globe we could say that similar types of noise may generate.

RADIATED NOISE FROM MARINE PLATFORMS AND ITS MANAGEMENT: A NEW PERSPECTIVE FOR INDIAN COAST GUARD

Dy Cmdt C.B Sheik, Indian Coast Guard

Introduction: Indian Coast Guard

The Indian Coast Guard (ICG) since its inception on 18 Aug 1978, as an forth armed force of the Union by the *Coast Guard Act, 1978*, has come a long way in its mission of protection of India's maritime interests and enforcement of maritime law with jurisdiction over both territorial (including contiguous zone & exclusive economic zone) and international waters. ICG started its operations with two small corvettes and five patrol boats transferred from the Navy in 1978, has grown up into a force of 166 surface platforms in the last four decades.

The Mine Threat

Over history and Great War number of countries used mines as their lethal weapon and caused huge damage to surface platforms. Mining is one of the old, effective and economical methods of fighting a battle at sea. A defence magazine reports that since the 1950, the US Navy has lost more ships to mines than to missiles, torpedoes, or bombs. Iraqi forces laid 1,300 mines against the U.S. Navy lead coalition force during Gulfwar. In 1950 Korean war, North Korea mined more than three thousand mines against United Nations amphibious task force. During World War II Nazi submarines laid 327 mines and sunk or damaged eleven ships. Throughout the Great War, Russia, Germany, Turkey, Great Britain, and the United States and so many countries relied on sea mines. In June–October 1918, British and American ships laid more than seventy-three thousand mines to sunk U-boats. U.S. laid some 12,200 mines in Japan's shipping routes and territorial waters and ports and sank or severely damaged some 670 Japanese ships during operation starvation.

These are easy to acquire, build and can be put in place by aircraft, surface ships, pleasure boats, gamines, rubber boats, submarines, merchant vessels, suicide divers and even from pickup trucks crossing bridges over critical waterways. Further they can also be fabricated from fiberglass or plastic, making them extremely difficult to detect, identify, or counter once in the water. They can be designed to fire in several ways: by contact, by sensing the signatures or "influences" of a surface ship or submarine, and on command. In addition they can be operated at depths less than ten-foot water depth to deep waters greater than two hundred feet and their payloads can range from a few pounds to several tons of high explosive. Acoustic mines are today programmed to target specific class of platforms based on their acoustic emissions referred as acoustic signatures due to their unique frequency characteristics by which they can be precisely identified. More than thirty countries produce and twenty countries export them.

India has fought 05 wars with China and Pakistan since its independence. Chinese string of pearls around India, CPEC and providing help to Pakistan in making nuclear weapons has bring these two countries together which can create a security threat. Credible reports suggest that Chinese are making mines available to the smaller nation states in the region.

The ICG platforms by the nature of their deployment and complementing Indian Navy during hostile situations will always be vulnerable to such subversive attempts by the anti-national elements. The naval platforms with their mine sweeping exercise as a mandatory Standard Operating Procedure (SOP) prior leaving harbour and further getting deployed in deeper waters are able to contain this threat to a considerable extent. However ICG do not have such capabilities as to date.

Acoustic Stealth

A complementary measure to minimize the vulnerability of platforms to acoustic mines, other than minesweeping, being practices all over the world is minimizing the acoustic emission levels, in other words, improving the acoustic stealth of the sea going platforms.

To ensure stealth of sea going platforms, there has to be a three pronged strategy. Right at the design stage to ensure proper selection of machineries and their foundation, resulting in minimal coupling of vibration into the hull followed by effective structural design and layout of machineries onboard to minimize transmission of radiated noise into the medium. Second is the construction stage, where the shipyard must ensure good engineering practices and high quality workmanship to make sure high levels of acoustic stealth. Finally, the maintenance philosophy and operational deployment strategy has to facilitate minimal transmission of radiated noise into the ocean.

Ship Building in India

The ICG platforms are all indigenously built by shipyards within the country. Post the Mumbai attacks in 2008, the ICG has obtained government sanction for massive force expansion between 2010 to 2019 and close to 275 platforms are likely to get inducted into the fleet for safeguarding the over 7500 km coastline. This entire fleet of platforms of various sizes and machinery fit are going to be constructed in our Public Sector Units (PSUs) and some private shipyards.

If there is one success story among the defence industry in India, it is the ship building sector. The indigenous shipyards are undertaking big projects including the first ever aircraft carrier project being underway at the Cochin Shipyard Limited (CSL). The government with an aim to encourage the promising ship building sector in the country, declared four PSU shipyards as **defence** PSU including CSL. Now having said that, let us ask ourselves the very important question as to “what is the single most important aspect that differentiates the defence industry from any other sector” and the answer is **stealth**.

Few quick points that need to be made at this point, that could be path breaking for this emerging ship building industry in this country and could possibly facilitate India becoming one of the credible exporters of ships/warships in future:

(a) Stealth or more specifically acoustic stealth is not a contractual obligation as yet for the indigenous shipbuilders. This issue needs to be deliberated and possible way ahead formulated.

(b) Even if we are able to establish, benchmarks for acoustic signature for various classes of platforms, validation of the platforms against these benchmarks need underwater ranges being commercially available on similar lines as the Indian Registrar of Shipping (IRS) with requisite infrastructure.

(c) The supporting industries supplying equipments/machineries being fitted onboard these platforms need to gear up to meet stringent vibration norms.

Way Ahead

The ICG with its limited in-house resources for ship building and maintenance is fully dependent on these shipyards for their operational availability and effective (stealth conscious) deployment at sea. The ICG attempting to create its own in-house resources for achieving desired levels of stealth similar to the Indian Navy, may not be a economically viable option, given the expansion requirement (being progressed already), technology and infrastructure requirement. Given the role being played by the ICG, the Ministry of Shipping could put forward some regulatory framework to initiate stealth consciousness of our shipyards. It is quite discouraging to note that even the **defence** PSUs have no mention of the word **stealth** in any of their mission statements or vision document.

Another important charter of duty that ICG carries out is Preservation and protection of marine ecology and environment including pollution control. Sound is the only effective way of communication in water. All marine species for example depends on sound for their biological critical functions like foraging, navigation, communication, echolocation, predator avoidance etc.

But in last few decades the oceans have become gradually louder due to increased shipping activities as well as the exploration of the oceans with invasive technologies such as seismic surveys and airguns. This sound propagation in ocean further categorized in to High Frequency and Low Frequency. High Frequency noise travels short distance and gets attenuated and dies down where as low frequency noise can travel thousands of kilometers. Further noise produced in the oceans is primarily categorized into natural and anthropogenic. Among these two anthropological noise is the dominant source which is effecting the marine habitat.

Natural Source: Wind, Waves, Eddies, Volcanic and Tectonic activities, earthquakes, surface rainstorms, lightening etc.

Anthropogenic Sources: Ships, Cargos, Warships, seismic activities, under sea mapping, sonar operation, research related activities, underwater explosions, ship shock tests, etc which produces low frequency signals. These activities generate low frequency noise which adversely impact the marine habitat and disturb the marine species communication. Due to this anthropogenic activities marine species suffers Physical injury, Tissue damage, blood clot, Stranding, physical dysfunction, Permanent or temporary hearing loss, auditory trauma, behavioral modifications, changes in foraging or habitat use pattern, masking and migration, loss of sensory abilities.

Sea routes are the economical and effective way of transport and dependence on the same is likely increase manifolds in near future. Commercial ships Propeller is the dominant source of underwater noise pollution. These propellers cause Cavitation which refers to the generation of vapor bubbles (cavities) within the water when the pressure is reduces below the vapor pressure limit. These bubbles produce low frequency noise which disturbs the marine habitat. This noise pollution level can be optimized by proper Propeller, Blade and Hull design, Optimizing propeller load, Careful selection of machinery, Installing Four stroke engines, Utilizing noise insulating materials, Ensuring uniform water flow and careful selection of the propeller characteristics (such as diameter, blade number, pitch and skew, regular ship maintenance and propeller cleaning and selecting noise efficient speed.

Regulations governing underwater noise pollution are almost non-existenting or very limited in India. The international regulatory bodies although have not promulgated this as a pollutant (MARPOL convention only recognizes substance pollutants and energy form is yet be recognized), however the catastrophic impact has certainly been accepted in various discussions and policy meetings. IMO in its convention in 2002 have officially accepted radiated noise as a hazard through its resolution A.927 (22). The International Council for the Exploration of the Sea (ICES) formed a study group on research vessel noise to address the concern over the effects of underwater noise radiated from research vessels. The Cooperative Research Report (CRR) No. 209 on Underwater Noise of Research Vessels, brought out in details the impact of radiated noise on several species and tried to formulate bench mark for radiated noise of research vessels. International Whaling Commission (IWC), has recognized the impact of radiated noise for the cetaceans, however due to the lack of clear cause and effect information and limited psycho-acoustic data on various species, has not been able to push for these in a regulatory frameworkDue to nonexistence of compulsion on under water noise levels profit oriented ship owners are not getting motivated to incorporate these noise reduction methods. Given the rising number of ocean related activities such as growing dependency in shipping transport, etc noise pollution is bound to increase further in the future. Hence firm regulations are required to be designed and implemented on underwater pollution. Following steps may be taken to reduce the underwater noise pollution.

(a) Designers, Shipbuilders and ship operators are to be encouraged to consider technologies and operational measures not included in these guidelines.

(b) Underwater noise computational models may be useful for understanding the ships behavior and the reductions possible.

(c) The shipping industry has to focus on available technologies to minimize the radiated noise emissions and probably invest in developing futuristic ideas to achieve higher levels of acoustic emission standards.

(d) A detailed assessment of the impact on the marine habitat and precise quantification along with qualitative ecosystem based understanding of the extent of damage need to be generated.

(f) A comprehensive framework of regulatory norms needs to be established to make it a statutory obligation for all the stakeholders to conform to the pollution levels.

Sustainable economic growth is possible only if we show equal concern for the environment and economic activities. One classic example is World did not paid required attention on air pollution during industrial revolution. And now we are not paying the required amount of attention towards marine pollution. Marine pollution may also become as severe as air pollution in near pollution.

Way Ahead

The ICG by an act of Parliament is also tasked to monitor and control maritime pollution. Acoustic habitat degradation as a result of noise pollution in the ocean is emerging as a serious concern, particularly in the Indian Ocean Region (IOR). The growing maritime activities with the booming economies are resulting in very high levels of underwater noise being radiated into the oceans. ICG needs to keep pace with the global efforts on containing noise in the ocean. Shipping noise has been recognized as the single ubiquitous source of noise in the ocean, with the documented increase of levels as 3 dB per decade since the 1950s. Apart from containing the noise from its own platforms, it has to join the global initiative on regulating marine noise pollution.

Conclusion

(a) There is an urgent need to recognize the acoustic stealth requirement for the ICG platforms. The specifications for new construction ships and even refit ships should have the stealth aspect incorporated.

(b) The mine threat for our sea going platforms cannot be discounted anymore and even the commercial merchant platforms are vulnerable to this threat. Operational philosophy has to take this threat into account.

(c) The ship building industry has to recognize the need for acoustic stealth and accept it as a contractual obligation while delivering ships particularly to the ICG (to start with).

(d) The government of India and more specifically ministry of shipping have to mull over the idea of instituting regulatory framework for incorporating stealth during the design and construction of sea going platforms in our indigenous shipyards.

(e) The class authority like IRS will have to gear up to take up this responsibility technically and infrastructure-wise. Taking advantage of the FDI they should be able to setup the infrastructure for ranging of ships and forward actionable recommendations for stealth monitoring.

(f) The supporting industries within India should upgrade their specifications as per international Military Standards (MIL STANDARD), for vibration specifications.

(g) The academic institutions could encourage naval architecture, underwater research and noise and vibration studies to provide trained manpower to implement this aspect of acoustic stealth. The Maritime Research Centre (MRC), can play a critical role in policy framework, technology support and human resource development.

IMPACT OF HEIGHTENED TRAFFIC ON THE ACOUSTIC HABITAT OF THE RIVER BRAHMAPUTRA

Amarjyoti Kumar

The Mighty Brahmaputra, which is the Ninth largest river in the world by discharge and the 15th longest. The meandering river originated in the Manasarovar Lake and emptying in to the Bay of Bengal while flowing through Assam valley.

Government has initiated different waterways in India and the second National Waterway is declared in the river Brahmaputra from Sadiya to Dhubri of about 891 Km.

Inland water transportation

Inland water transportation (IWT) is an economic, fuel efficient, environmental friendly and a low cost transport mode. This mode includes natural waterways such as navigable rivers and artificial ones such as canals. The major advantage of waterways from the point of view of transport is that it offers less resistance to traction at reasonable speeds than other modes. The cost of maintenance is low as the channels are almost natural.

Only National Waterways come under the purview of the central government/IWAI while other waterways are in the domain of the respective state Governments.

Among the latter only a few states like Goa, West Bengal, Assam and Kerala have some organized movement of cargo by inland waterways.

Advantages of IWT

- Low capital cost
- Low maintenance
- Low fuel cost

The Government support that has been outlined in the policy document will be in terms of the following:

i. Conduct of pre-feasibility study of the project identified for private investment and results made available to prospective investors.
ii. Support for facilitating long-term cargo assurance.
iii. Option for IWAI to have equity participation up to 40 % of the project cost.

Trends in the Shipping Industry and Shipping Noise

The technical session of the current information and predicted trends in the number, type, and routing distributions of large commercial vessels in the water ways were initiated now a days. Also we should considered the measurements of radiated acoustic fields for certain vessel classes and trends in ambient noise levels potentially related to increased shipping density in various areas.

a) Commercial fleet: current and future numbers and trends

Trends in vessel propulsion systems are advancing toward faster ships operating in higher water states for lower operating costs. In terms of other design features, ships are becoming narrower, and using medium speed diesels, with hull designs involving catamarans, trimarans, and pentamarans. Container vessels are expected to become larger along certain routes in the near future. This trend is not immediately expected for tankers.

b) Sounds produced by individual vessels

Large commercial vessels produce relatively loud and predominately low frequency sounds, the exact characteristics of which depend on vessel type, size, and operational mode. Most 83 % of the acoustic field surrounding large vessels is the result of propeller cavitation. When ships cavitate, relatively little acoustic energy is transmitted into the water from on-board machinery or movement of the vessel through the water.

c) Trends in marine ambient noise: contributions from vessels

The sounds of individual vessels can contribute to overall ambient noise levels on variable spatial scales. Whether such contributions have adverse impacts on marine mammals, and their biological significance, is unknown.

Needed research and possible future actions

- Develop a global passive acoustic monitoring network to measure ambient noise levels in a variety of locations.
- Integrate empirical ambient noise data over time with detailed information on trends in vessel design and operation to assess the most appropriate global economic indicators in terms of shipping and other vessel noise.
- Determine how increases in vessel routing density

<u>Effects of Noise on Marine Life</u>

The technical session on hearing and the effects of noise on various marine animal groups.

a) Effects of vessel noise on marine animal hearing

Noise exposure may result in a range of effects on auditory and non-auditory systems. Noise may be detectable, but have no effect on an animal's behaviour, hearing, or physiology. Signals of interest may be interfered by the presence of noise. More intense exposure may result in either temporary or permanent changes in hearing sensitivity.

b) Effects of vessel noise on marine animal behaviour

A limitation in considering the effects of anthropogenic noise on marine mammal behaviour is that most studies are observational rather than experimental. In many conditions, particularly with regards to the effects of noise from large vessels on marine mammal behaviour.

<u>Needed research and possible future actions</u>

- Improve estimates and obtain direct measurements of hearing sensitivity in representative large species.
- Continue to develop new technologies to test hearing in marine animals that are more rapid, more objective, and can be used on more individuals than possible with current behavioural techniques.

Developing Technologies for Monitoring Marine Noise

Acoustic measurements conducted to indicate diurnal and seasonal patterns in both natural and anthropogenic sound sources in most environments. The large deviations from nominal ambient noise conditions that may be observed during a large discrete disturbance such as the passage of a large storm or a very nearby vessel. Measuring deviations from mean or median ambient values is useful in describing noise variability in an area. The presence of such variability points to the possibility of obtaining much skewed information about typical noise parameters in an area if sampling is not sufficiently frequent or pre launched.

Vessel Quieting Technology: Applications and Benefits

The technical session of the current information and predicted trends in vessel quieting technologies.

a) Commercial and military vessel quieting technologies

The military has a relatively long history of quieting vessels to reduce their acoustic signature and thus vulnerability to detection by enemy passive acoustics.

Commercial applications of ship quieting technology are more recent and less widespread, though growing in such areas as cruise ship and acoustic research vessel design.

There are some commonalities in both military and civilian contexts to reduce radiated vessel noise based purely on the physics of sound and constraints of vessel design. Efforts at reducing noise are most effective when incorporated into the design of ships, though retrofitting of vessels may also be successful to varying degrees, but certainly at relatively high cost.

For minimizing mechanical acoustic radiation from vessels, developing quieter equipment, a number of sounds isolating and absorbing techniques are employed. Modern diesel electric engines may be fitted with resilient isolation mounts, flexible hoses, and pipe hangers to minimize radiated sound.

b) Potential applications of quieting technologies to commercial industry

Through advances in both military and commercial uses of vessel quieting, the technology by which commercial vessels could be significantly quieted already exists. Optimal quieting is achieved when this goal is incorporated into the design of vessels and strictly adhered to during construction. The duration between the design and operational phases of large vessels is a long-term solution to minimizing the contribution of large vessels to overall ocean ambient noise. Refitting of existing ships with particular attention to the installation of non-cavitation propellers is a more feasible short-term solution. This is also an expensive and possibly cost-prohibitive procedure. The acoustic energy radiated into water by transiting ships represents wasted energy that could be used to more efficiently propel the ship forward making such

modifications may have the dual benefit of reducing radiated noise and reducing vessel operating costs.

c) Cost and benefit analysis for the application of vessel quieting technologies

While there is no debate as to whether large commercial ships could be quieted with the application of mature vessel quieting technologies. There will be no consensus as to whether the need for this is clear based on our current understanding of impacts when this is likely to occur.

There are considerable costs associated with the application of these technologies either in the construction of new vessels or in refitting existing ones. Vessel quieting with 'standard' reduction measures will likely require only a small increase in cost. Modifications are less likely to be cost-effective for commercial applications including many naval and research vessel silencing techniques and padded electric propellers.

Needed research and possible future actions

- Conduct a complete cost/benefit economic analysis of the application of various vessel-quieting techniques to large commercial ship design and operation.
- Compare the advantages and disadvantages of retrofitting existing ships versus concentrating on the design and construction of new vessels.

UNDERWATER RADIATED NOISE ANALYSIS: COMMERCIAL, ECOLOGICAL & DEFENCE IMPLICATIONS IN IOR

Karan Krishna Bhat

Oceans have never ceased to fascinate human beings. Not just because its so vast and inaccessible in spite of all the major technological advances achieved, but also that it still gives a plethora of new discoveries at every attempt made to explore its crevasses. This has lead the major economies of the world to invest trillions of dollars to harness the immense resources of the oceans. Among one of these efforts is the development of acoustic technology, to explore the unknown depths of oceans and eventually to gain advantage over competing adversaries in varying geopolitical interests. With a coastline of more than 7000 km, India has historically been a maritime nation. Ancient and medieval texts depict our prowess in naval and merchant shipbuilding, implying the deep understanding of various nuances of maritime science. However, India after colonialization period has lagged behind in the technology race. Since acoustic capacity building contributes in big way to contemporary ways of shipping, fishing, and maritime defence– which are major stakeholders in any maritime nation, such as India – there is a tremendous need to develop this capacity in order to harness the best of capabilities in maritime domain, which will definitely be greatly benefited by improvements in radiated noise analysis methodologies. With the help of modern technology and scientific research India can regain its former glory and once again become a proud maritime nation.

Acoustic waves travel at a speed of about 1500 meter per second in water – about 5 times faster than in air, unlike other energy waves (such as radio and light waves), which makes these waves well suited for underwater applications. Breaking of icebergs, blowing winds, action of waves, marine mammal sounds and other phenomenon contribute to persistent background noise that is often termed as ambient noise; and noise created by human activities is broadly termed as anthropogenic (radiated) noise. Acoustic radiated noise reveals a lot about the nature of the object, such as, its characteristics, its working condition, etc. Application of acoustic waves in the oceans is a well-studied and documented phenomenon, with lot of new developments surfacing regularly in scientific community. However, lot of unsolved mysteries still remain to be explored, with promises of surprising discoveries.

With continuously evolving shipbuilding methodologies, underwater weapon design and niche communication systems, factors such as stealth detection, mine deployment/detection, locating and targeting of enemy vessels have become increasingly important to counter and eliminate the growing threat to Indian maritime interests; here, radiated noise analysis plays an important role in characterization of acoustic signature of ships and submarines which can be subsequently used for countermeasures, pre-emptive strikes as well as situation monitoring of deployed vessels. Thus, radiated noise analysis sees extensive use in military applications. Among non-military applications, we mainly see commercial and ecological aspects.

Development of methods for noise analysis has commercial implications of varied forms, such as, better locating of fish school leading to sustainable fishing techniques, monetizable technology development and maintenance; while ship health monitoring is another crucial aspect - cost effective report generation can be carried out using radiated noise analysis. Low cost tracking, locating and classification of ships based on unique acoustic signature is another major aspect which makes extensive use of results from. Analysis of Radiated ship noise is also necessitated to reveal the range of frequencies and other properties that may be affecting the marine species; causing interference to various activities like mating, locating, and communicating which are predominantly acoustic based, which has led to disruption of ecological cycle and in some cases even extinction of species. IOR is rich in flora and fauna, and for protection and conservation of these novel creatures radiated noise analysis is indispensable.

Due to complex nature of the radiated noise, its analysis using various techniques to identify the prime radiating sources for correct study and documentation of noise characteristics is not so straight forward. This whole process involves determination of various parameters from the acoustic signals captured by underwater sensors, which is pre-processed to remove any possible errors caused by data corruption; tools such as Fourier, Hilbert & Wavelet transformations are applied to extract spatiotemporal and frequency domain information from the processed data. From this information one estimates the various parameters of the radiated noise, by employing various statistical methods such as non-parametric and parametric model development. Modern acoustic signal processing makes use of methods like Low Frequency Analysis and Recording (LOFAR) for Broadband Spectral analysis, Demodulation of Envelope Modulation on Noise (DEMON) for Narrowband analysis, cross spectral methods and various approximation methods; these are extensively used to carry out analysis of radiated noise.

However, the above methods are, in various stages, largely manual processing of the data collected from sensors, which are prone to human error often arising from lack of sufficient skills and instrument handling experience; or even occasional negligence arising various factors. Moreover, the entire process is very time consuming and tedious, many stages being redundant. Errors have tendency to compound over different stages and thus may lead to wrong judgements, jeopardizing the entire operation. A completely automatic system for radiated noise analysis, whose development is main aim of this project, strives to not just give a comprehensive parameter report of the ship, but also to detect any anomalies arising in ship's operation, which will act as highly reliable source for further diagnosis. This not only effectively eliminates the shortcomings of manual errors but also puts into place a system that can do a routine task efficiently, which is not humanely possible; information from which may even be used as feeder for long term decision making systems, making the whole process autonomous. Automatic systems can be constantly improved and evolved to conform to international standards of operations, allowing the process to be at par with global performance requirements.

Automatic analysis systems can be developed by smart application of robust and well tested methods such as machine learning, deep learning, fuzzy logic and artificial neural networks which eliminate requirement of pretraining of machines using sensitive data, allowing the system to be standalone which can be directly setup on the go at the required site. Large amount of data can be efficiently processed via means of High Performance Computing (HPC) leading to possibility of setting up of real time systematic monitoring and processing of radiated noise, without any human intervention and at the same time facilitating upgradation and modification of associated algorithms as and when better ways of doing analysis of radiated noise are developed. Modern data processing techniques like H2O and MapD allow visualization of the results giving better idea of the information extracted from noise analysis. This project thus aims at not only developing a reliable system that improvises with real time data but also attempts to offer a long-term solution to the needs of various entities that depend on results from radiated noise analysis.

I would like to thank my guide and mentor Dr. (Cmdr.) Arnab Das who has inspired and encouraged me with his continuous, visionary and friendly guidance, in all aspects, to take on this challenging project. By doing this project, in addition to fulfilling the academic requirements of masters, I strive to contribute, in howsoever small way, to make this nation great again.

ACOUSTIC HABITAT ASSESSMENT OF IRRAWADDY DOLPHINS BASED ON THEIR VOCALIZATION

Jayashree Deka

Introduction: Irrawaddy dolphins have been declared as data deficient species by IUCN red report. They are mainly found in coastal, brackish, fresh water and near shore habitats as they are facultative in nature. They are spread across lake and rivers of Indonesia, Myanmar, Phillipines, Thailand, Cambodia, India and Bangladesh. Their bio-sonar characteristics are highly sensitive to their environment. A good understanding of their bio-sonar characteristics across different habitats can act as potential input for conservation. Human encroachment into their habitat has an adverse impact on to their population size. Thus human activities, often resulting in dramatic declines in their abundance and range. Human encroachment in the water bodies accompanied with enhanced acoustic emissions that significantly interfere with the perception of the habitat by these species. This is referred as acoustic habitat degradation and any conservation efforts requires a comprehensive acoustic habitat assessment for the species. The acoustic habitat assessment includes analysis of their vocalisation, impact of physical parameters on their vocalisation, detailed understanding of the source-path-receiver model to comprehensively assess the source of habitat degradation. In this work the acoustic habitat assessment of Irrawaddy Dolphins in the Chilika Lake and Sunderban's mangrove forest has been done.

Data Acquisition & Analysis: Array with four hydrophones is used for data collection from Sunderban's mangrove forest and array of four hydrophone is used in Chilika lake. The recording depth in Sunderban varied from 6.5m to 23m.Recordings took place during daylight and sampling frequency used was 500kJHz and resolution of 16bit was selected.

Data analysis was carried out using Matlab. The sounds were stored to wave files that could be linked to database with time and date of the recording, location, group size and composition and spatial distribution.

Results and Discussion: As depth and salinity varies in these two distinct habitats, their acoustic behaviour varied accordingly. It is found that there have been significant a difference in their vocalizations in terms of amount of time vocalizing, shape, duration and frequency of clicks.

Also the psychoacoustic behaviour of these dolphins have been observed.

In this project, the considerable impact of two distinct habitats on their acoustic behaviour is assessed and it is observed how greatly their vocalization has been modified due to habitat degradation.

ACOUSTIC SENSOR NETWORKS FOR UNDERWATER DOMAIN AWARENESS IN INDIAN OCEAN REGION

Digambar Puri

Oceans cover about 71% of the Earth's surface, but most of them have not been explored up to now. Recently, there has been a growing interest in ocean exploration activities. The marine conservation in India have been a challenge due to the complex interplay of issues. The conservation initiatives, largely lead by marine biologists has ignored the all important aspects of acoustics. India is most beautiful country which has got the more the 7,517 km coastline. The unique characteristics of the Indian Ocean Region (IOR) politically, economically, socially, technologically and other coastal and marine concerns needs to be articulated to a vast range of stakeholders. The comprehensive Underwater Domain Awareness (UDA) has to be an integrated concept and the technology development, operational and maintenance processes have to evolve to satisfy all four (security, environment, industry and the research) stakeholders.

Underwater wireless sensor networks (UWSNs) are the enabling technology for a new era of underwater monitoring and actuation applications. Acoustic communications in underwater environments have been recognized as one of the most advantageous ways to transmit information. UWSNs are an underwater monitoring system consisting of nodes with sensing, computing and acoustic communication capabilities. Underwater wireless sensor networks (UWSNs) have many potential applications, including seismic monitoring, equipment monitoring and leak detection, and supports for swarms underwater robots, pollution control, climate recording, prediction of natural disturbances, Study of marine life.

A generic UWSNs, comprises of sensors mounted on heterogeneous underwater vehicles and fixed in-situsensors that possess acoustic through water communication deployed for oceanographic surveys, observation and monitoring. Assortment of underwater autonomous vehicles, autonomous surface vehicles, and bottom mounted and moored instruments and gliders generate the persistent special coverage over extended areas and also supports critical communication and navigation requirements. The above water satellite connectivity to shore provides the real time access to the UWSNs to enable data transfer and control. The individual elements of UWSNs can be configured in multiple ways for gaining access to the underwater domain and address diverse oceanographic problems. Long term environmental monitoring of deep water and Arctic oil and gas field has been one such application where conventional power and communication has been a crisis.

Designing of underwater sensor networks is a real challenge. There is highly tread-off between terrestrial and underwater networks. Cost, communication method, communication medium, transmission loss, noise, node mobility, memory requirement, multipath differentiates terrestrial and underwater networks. Practically 2-D or 3-D architecture since in 3D underwater networks there may be no notion of uw-sink, sensors should be able to relay information to the surface station via multi-hop paths. Thus, network devices should coordinate their depths in

such a way that the network topology is always connected, i.e., at least one path from every sensor to the surface station always exists. Sensing and communication coverage in a 3D environment are rigorously investigated. The diameter, minimum and maximum degree of the reachability graph that describes the network are derived as a function of the communication range, while different degrees of coverage for the 3D environment are characterized as a function of the sensing range. These techniques could be exploited to investigate the coverage issues in UWSNs.

SUSTAINABLE SYSTEM TO MANAGE DESILTATION OF BRAHMAPUTRA RIVER

Nisha Kalita

Silt is solid, dust-like sediment that water, ice, and wind transport and deposit. Silt is made up of rock and mineral particles that are larger than clay but smaller than sand. Individual silt particles are so small that they are difficult to see. To be classified as silt, a particle must be less than .005 centimetres (.002 inches) across. Silt is found in soil, along with other types of sediment such as clay, sand, and gravel.

Silt is created when rock is eroded, or worn away, by water and ice. As flowing water transports tiny rock fragments, they scrape against the sides and bottoms of stream beds, chipping away more rock. The particles grind against each other, becoming smaller and smaller until they are silt-size. Glaciers can also erode rock particles to create silt. Finally, wind can transport rock particles through a canyon or across a landscape, forcing the particles to grind against the canyon wall or one another. All three processes create silt.

Silt can change landscapes. For example, silt settles in still water. So, deposits of silt slowly fill in places like wetlands, lakes, and harbours. Floods deposit silt along river banks and on flood plains. Deltas develop where rivers deposit silt as they empty into another body of water.

Many species of organisms thrive in slick, silty soil. Lotus plants take root in muddy, silty wetlands, but their large, showy flowers blossom above water. Many species of frog hibernate during the cold winter by burying themselves in a layer of soft silt at the bottom of a lake or pond. Water at the bottom of a body of water does not freeze, and the silt provides some insulation, or warmth, for the animal. Silty soil is usually more fertile than other types of soil, meaning it is good for growing crops. Silt promotes water retention and air circulation.

Main Causes of Siltation are:

1. **Soil Texture:** Small grain and open structure soil erodes more than the larger grain and closed structure soil

2. **Ground Slope:** Steeper slope ground erodes more than the ground having mild slope due to increased speed of run off than infiltration.

3. Intensity and amount of rainfall: More the intensity of rainfall more will be the soil erosion.

4. **Mismanaged utilization of soil resources:** The soil erosion is enhanced by improper surface drainage, removal of forest litter, overgrazing etc.

5. Distribution of rainfall and landscape*:* If the ground surface is such that rainfall distributes evenly, there is not plenty rainfall, the erosion will be less.

6. Deforestation: It is one of the major factors responsible for soil erosion. Removal of forest cover which function as a binder of the top layer of the soil with increasing land demand have resulted in enhancing extent of soil erosion.

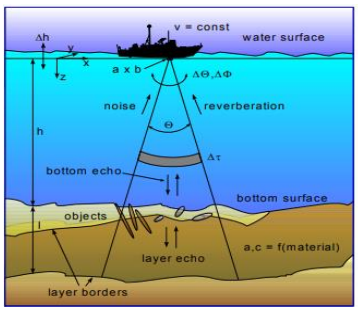
Silt removal is necessary when the breakdown of dead plant leaves and other organic material along with runoff from surrounding fields causes a build up on the bed of a lake, pond or river. This can have serious consequences on the future of that water and the life there is within it. The build up of silt will lead to a reduction in water depth of the watercourse, increased risk of flooding, and the release of nasty smelling odours from the process of biological decomposition and potentially the loss of the watercourse. In areas that use chemical fertilizers, runoff can make silt toxic. Toxic silt can poison rivers, lakes, and streams. Silt can also be made toxic by exposure to industrial chemicals from ships, making the silt at the bottom of ports and harbours especially at risk.

Desilting, as the name indicates is removal of silt (fine grained clay/lake-bed soil) from a lake-bed, can be done manually, but usually mechanically. Dredging is one such method for desiltation in the water bodies. Dredging, as a process, is used to remove the deposits percolated underwater for the purpose of clearing the water pathway for ships to pass; to create adequate space to construct important bridges, dykes and dams and to weed out silt, intoxicants and pollutants from the bottom of the water. With their increased size, ships need improved navigation channels to enter and leave ports efficiently, quickly, and safely. Once sediments are dredged from the waterway, they are called dredged material. Without dredging, many harbours and ports would be impassable to passenger liners and cargo ships. Consumer product prices stay low when ships can transport their goods directly into the port.

A dredge is a machine that scoops or suctions sediment from the bottom of waterways or is used to mine materials underwater. There are two methods of dredging: mechanical excavating and hydraulic excavating.

Mechanical excavating is applied to cohesive soils. The dredged material is excavated and removed using mechanical means such as grabs, buckets, cutter heads or scoops. Hydraulic excavating is done with special water jests in cohesion less soils such as silt, sand and gravel.


The navigation potential of the Brahmaputra is immense but in desperate need of an overhaul. Cargo vessels are rarely seen and passengers are transported in rickety wooden boats. But developing the Brahmaputra into an international waterway, as envisaged in the National Waterways Act, could give the state of Assam and the rest of India's northeast an edge and make it India's link to ASEAN nations as the government's Act East policy. The Brahmaputra National Waterway 2 – an 890 kilometre-long reach of the river from Sadiya in Assam to the Bangladesh border – could act as the economic corridor to international ports such as Chittagong in Bangladesh and Haldia Port in West Bengal, boosting trade with Southeast Asian countries. To realise such a future, a tripartite agreement for dredging the Brahmaputra was signed between the Assam government on one hand and the Indian inland waterways and national highways authorities on the other at the closing ceremony of the Namami Brahmaputra Festival in Guwahati in April. Dredging companies and local authorities are interested in exact information about the dredging area and material conditions, like sediment structures, sediment types and sediment volumes especially in ship channels and harbours. To get this information sediment equipment for sounding echo is used.



There are some important parameters to classify echo sounder system:

1. **Directivity:**

The directivity of the transmitted sound beam depends on the transducer dimensions related to the sound frequency. There is a main lobe with the beam width and side lobes. The sound at the border area of the main beam has a longer travel time than the sound in the centre of the

beam. This makes the reflected signal longer than the transmitted signal. Particularly in deep water areas where refraction due to changes of the sound velocity may enlarge the sounded bottom area and that makes the echo signal longer.

2. **Frequency, pulse length, pulse ringing and pulse repetition rate:**

The attenuation of sound inside the sediment layers is most important to the penetration depth that can be expected. For greater penetration depth lower frequencies should be used. On the other hand the vertical resolution depends on the pulse length of the transmitted signal. Shorter pulses will result in better resolution, which could mean using high frequencies.

3. **Beam steering and stabilizing, heave compensation:**

Caused by rough sea the transducer may move during the survey in 6 directions. The most important unwanted motions are roll, pitch and heave. They should be compensated if high-resolution echo prints are required. Therefore beam stabilizing should be possible, especially at greater water depths.

4. **Real time signal processing and size, weight, mobility:**

The echo prints should be calculated in real-time to get first survey results immediately. Thus makes a powerful real-time signal processing necessary.

Conclusion:

Siltation is a natural process and silt is rather useful for various activities. But over accumulation of silt in the river/sea beds due to reasons mentioned above makes the life of humans difficult and troublesome. The method of desiltation was adapted to overcome this. Dredging is one of the methods of desiltation which is used in water to remove the over accumulated silt so as to allow the movement of various ships. Although dredging is not desirable due to the effects caused by it to the marine life, but till the activities resulting in over accumulation or making the silt toxic takes place, dredging remains a solution to it. Dredging although is a solution but still it is not at all a cost friendly one. Dredger ships are brought from the Dredger Corporation of India with high bids and are used for desiltation of the river or sea beds. The silt removed may undergo open water disposal, which refers to the placement of water in rivers, lakes, estuaries or oceans or confined disposal, where the dredged material is placed within diked near-shore or in upland confined disposal facilities. Confinement or retention structures enclose the disposal area above any adjacent water surface, isolating the dredge material completely. This untouched dredged material is of great value in terms of economic as well as cultural. The constituents of the dredged material may include sand, gravel and /or rock.

The constituents of bricks include: Silica, Alumina, Lime, Iron Oxide and Magnesia.

The unused dredged material left untouched can be used by the brick building companies by undergoing some processes so that the required material can come out and be used efficiently. The revenue generated from selling of the bricks can be used for buying the dredger ships which generally costs a ton. This is an optimum solution for using the dredged material efficiently.

INFRASTRUCTURE REQUIREMENT FOR A SAFE, SECURE AND SUSTAINABLE GROWTH MODEL IN THE RIVER BRAHMAPUTRA

Ushmita Deka

Brahmaputra is a mighty river. It flows through Tibet Autonomous Region of China, the Indian states of Arunachal Pradesh and Assam, and Bangladesh. It is culturally very important for the people of North eastern states of India. Economically also it is of high significance. Government has invested approximately One Hundred Crore Rupees for the development of National Waterway Number-2 in the river Brahmaputra. Brahmaputra also has a rich flora and fauna. The fresh water Dolphin found in river Brahmaputra are very unique. They are blind and use acoustic signals for hunting and communication. Despite being so rich and mighty there are several problems associated with the river Brahmaputra. Since it lies in North Eastern region of India which lies between Eurasian and Indian plate, it is seismic prone. Also since it flows through Bangladesh, the presence of non-state actors there makes it a way for those non-state actors entering India. There is high siltation in the river Brahmaputra. Currently its depth is about 120 metres. The depth is to be maintained for the river to be navigable. All these give rise to a requirement of an infrastructure for a safe, secure and sustainable growth model in the river Brahmaputra.

SAFE, SECURE AND SUSTAINABLE GROWTH

Safety is basically safety against natural calamities like earthquake, flood, cyclones etc. Since river Brahmaputra lies in seismic prone region it is important to design early earthquake warning system. Presently only Japan has its own early earthquake warning system. They have set up cable observatories under sea to detect the P waves. An earthquake has two types of waves- P waves and S waves. P wave stands for Primary wave which is generated first and is of shorter wavelength and also less destructive whereas S waves or Secondary waves have longer wavelength and are more destructive. Fortunately P waves are faster as compared to S waves. When an earthquake occurs, first P waves are emitted and after some time S waves are emitted. The sensors sense the P waves and warn the general public. The early earthquake warning system is run by Natural Research Institute for Earth Science and Disaster Prevention. Japan's Meteorological Agency sends out the earthquake warning.

Security is basically from external and internal threats. There are various militant groups in North East. Since the roadways are regularly under surveillance, it is most likely that the movement of these groups and their arms and weapons are through the waterway. Also there is a high presence of non-state actors in Bangladesh who can easily use the waterway for entering into India. U.S. Navy has a system of acoustic sensors for monitoring water vessels. Also Indian Coast Guard have VTS or Vessel Tracking systems through which they monitor each water vessel entering the Exclusive Economic Zone or EEZ of India with the help of AIS

or Automatic Information Systems of the ships. AIS servers have basic information about each ship.

Sustainability of the ecosystem in river Brahmaputra is very important. River Brahmaputra has as a high siltation rate. Therefore it is very important to carry out dredging regularly for keeping the water of Brahmaputra navigable. The Dolphins found in the river are endangered. Therefore it is also important for locating them and protecting them. Fishing during the breeding season must be avoided.

REALIZATION INFRASTRUCTURE

For safety from earthquakes, the sensor will sense the P waves during earthquake and then it will send it to the server in electromagnetic form. Now since the electromagnetic wave travels at around speed of light, it is faster than the acoustic S wave which is destructive. Therefore we can warn the general public about a major earthquake in advance. Accordingly the high rise buildings, schools etc. can be evacuated and all other safety measures are to be taken.

Similarly for security if the AIS or Automatic Information System is installed in every water vessel, then it is easy for the surveillance team to monitor the ship activities and also to locate foreign ships. If they sense some anomaly they will report it to the Security forces and the Security forces will take appropriate steps. Another way is to use an acoustic sensor to sense the noise generated by the water vessels and to locate the vessel. Since the same sensor will also sense the presence of fishes, therefore it is easy for the person or system monitoring to locate alomaly and inform it to security forces.

For maintaining the sustainability of river Brahmaputra, one needs find the appropriate siltation level. This can also be done by the sensor. Regularly the siltation level must be made available to the siltation control division. The fishing laws must made stricter and proper implementation must be guaranteed. Avoiding fishing during breeding season is one of them.

Setting up different sensors for different purpose will result in heavy cost. Therefore sensors which can perform all these functions are required. That is we will design a common sensor that can detect seismic waves, noise generated from water vessel as well as level of siltation and river Dolphins. The data collected by the sensor will be huge. Therefore proper big data handling tools like Data Science, Anaconda,h2O etc. are required. The data should be made available to different concerned authorities via servers. Organizations that should receive the data are: Environmental monitoring department, Surveillance department and Institutions maintaining siltation levels. Artificial intelligence should be brought into existence for every institution as it reduces error. It also makes the system more standard.

CONCLUSION AND FUTURE SCOPE

Same system can be used for detecting earthquake as well as patrolling. The cost of maintaining and setting up such system is very high. A lot of research is needed in this field. in terms of - Technology, Biological sciences and Geological sciences. Creating meaningful man power is a necessity. Standardizing the work procedures and giving proper training to the workers bring down maintenance cost heavily as the machines are operated correctly.

MODELLING CUMULATIVE ACOUSTIC ENERGY FROM SHIPPING IN INDIAN OCEAN REGION

Jaswantsing Rajput

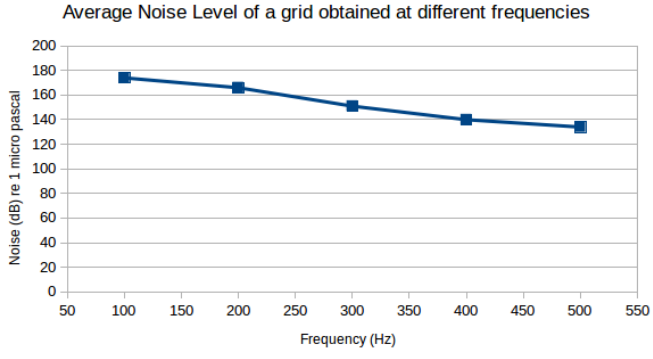
The ocean is an extremely complicated acoustic medium. The most characteristic feature of the oceanic medium is its inhomogeneous nature. There are two kinds of inhomogeneity, regular and random, and both strongly influence the sound field in the ocean. For example, the regular variation of the sound velocity with depth leads to the formation of the underwater sound channel and, as a consequence, to long-range sound propagation. The random inhomogeneity give rise to scattering of sound waves and, therefore, to fluctuations in the sound field.

Noise from Individual Ships and Boats

Databases of radiated noise measurements exist for some classes of surface ships. The largest collection of deep-water merchant ship radiated noise measurements probably is the Lloyd's Registry of London database. Source spectral densities for the five classes of surface ships are used in the ANDES (Ambient Noise Directionality Estimation System**)** models. The curves for the two models differ according to the way the various classes are defined and the modelling approach taken, the levels in ANDES depend solely on the class of ship, whereas ship length and ship speed are used to calculate a scaling factor based on empirically derived power laws in the RANDI model. (The ANDES source spectral densities also are used in the newly developed Dynamic Ambient Noise Prediction System. Using the RANDI model, source spectral density levels ranges from more than 195 dB re 1 µPa2/Hz at 1 m around 30 Hz for fast-moving, large super tankers.

The radiated noise levels and characteristics presented in Fig below is of two ships broadly matching with the low frequency ambient noise curves proposed by Wenz and Knudsen. The radiated noise spectrum is largely dominated by the broadband cavitations component with its peak varying between 100 Hz to 1000 Hz. The higher the ship speed, the lower will be the location of the cavitations peak on the spectrum with enhanced intensity. The size of the vessel has a direct impact on the radiated noise level corresponding to larger power rating of the machinery on board and also higher number of on board machinery to manage higher level of functionality.

The 1/*f* variation in the ambient noise level is clearly observed and beyond 500 Hz, the other sources of noise including wind and biological noise dominate the ambient noise spectrum.



The focus of this study is on shipping traffic and its contribution to the low frequency ambient noise, hence the ambient noise beyond 500 Hz has not been considered, since beyond 500 Hz other parameters such as wind noise start dominating the shipping noise.

Conclusion & Research Scope

The low frequency ambient noise is a major cause of acoustic habitat degradation particularly for the big whales and we are already observing frequent stranding of such marine mammals all along the global coastlines. The direct link between the shipping traffic to the growth engines of the economy is a very complex geopolitical issue to deal with. The shipping traffic is only going to rise and thus the corresponding low frequency ambient noise is also going to rise. A detailed analysis on low frequency ambient noise and field study by Donald Ross reveals that the ambient noise due to shipping has continuously increased at the rate of 3 dB per decade since the 1950 (since the data has been recorded).

The acoustic habitat degradation is a major conservation concern and needs to be addressed at the highest political level. Conservation efforts typically in many developing countries particularly in the IOR are yet to account for the acoustic habitat degradation. The lack of awareness among stakeholders and policy makers and also absence of experts with acoustic understanding among conservation activists and technocrats is another issue to deal with.

In this work, I have presented a pilot survey for computation of the low frequency ambient noise in the IOR. The study is a unique effort that accounts for the local tropical littoral medium impact along with the spatio-temporal shipping traffic data. The study can be replicated for the entire 2.4 lakh Sq. km of Indian Exclusive Economic Zone (EEZ) and beyond for the entire IOR. The computational intensity is a concern to make it a dynamic map for real time output. The terrestrial vs. satellite fed for the AIS data is another issue to deal with.

Indian Ocean has gained tremendous importance over the years and has now become the most concerted area where global economic activity conjoined political interests [16 This is particularly important in an era in which global shipping has burgeoned. Today, the almost 90,000 vessels in the world's commercial fleet transport 9.84 billion tonnes per year. This represents an almost four-fold increase in the volume of commercial shipping since 1970.

The increase in shipping also constitutes to increase in the total ambient noise that is generated by movement of vessels above the water surface. Ocean ambient noise, or the background din of the sea, is generated by a variety of sources of both natural and anthropogenic. The river linking projects established by the Indian Government requires a study on its impact on the environment. It is crucial to attain information on the ambient noise generated due to the river linking establishment and also the ambient noise levels that already exist in the area before the projects are implemented so that it does not cause further harm the marine environment. This study shows that how anthropogenic noise affects the life of marine mammals and marine habitat ecosystem too. This study shows anthropogenic shipping noise generated during a day,(9^{th} March 2018) in a Mumbai region of Indian Ocean. As Mumbai region is an important harbour link of Indian Ocean, there is vast scope for research in the Mumbai region.

ACOUSTIC HABITAT ASSESSMENT OF BRAHMAPUTRA RIVER DOLPHINS

Ilakshi Deka

With thanks to: Dr (Cdr) Arnab Das, Director Maritime Research Center, Pune.

The Brahmaputra River Basin consists of the Ganges and Brahmaputra, which originates in Tibet and the Barak River starting in India. These rivers all converge in Bangladesh as the Meghna River and flow out to the Bay of Bengal. The river basin is a wide land area made up of parts of India, Tibet, Bhutan, Nepal, and Banglades..

Gangetic dolphin is found in Ganges-Brahmaputra-Meghna and Karnaphuli river system of India, Nepal and Bangladesh. According to the older generations of Assam, the Gangetic dolphin was one of the commonly sighted aquatic mega-fauna in the Brahmaputra river system before two decades. However, due to increasing anthropogenic pressures, the overall population of the species has been declining in such a way that currently most of the major tributaries of Brahmaputra are devoid of any dolphin population and even in Brahmaputra River also, the species is found in certain pockets only.

The Brahmaputra River survey recorded altogether 197 dolphins (27 calves, 32 sub-adults and 161 adults) spreading in 82 locations of the river with an encounter rate of one dolphin per 3.8 km. Altogether 28 dolphin (three calves, six sub adults and 19 adults) were recorded in the river stretch from Assam-Arunachal Pradesh border to Bogibeel (Dibrugarh); 23 dolphins (seven calves, two sub adults and 14 adults) in the river stretch from Dibrugarh to Nimatighat; 54 dolphins (10 calves, 10 sub adults and 34 adults) in the river stretch from Nimatighat to Silghat (Koliabhumura); 26 dolphins (two calves, three sub adults and 21 adults) in the river stretch from Silghat to Guwahati; 25 dolphins (four calves, five sub adults and 16 adults) in the river stretch from Guwahati to Pancharanta (Jugighopa) and 41 dolphins (one calves, six sub adults and 34 adults) were recorded in the river stretch from Pancharatna to India-Bangladesh border.

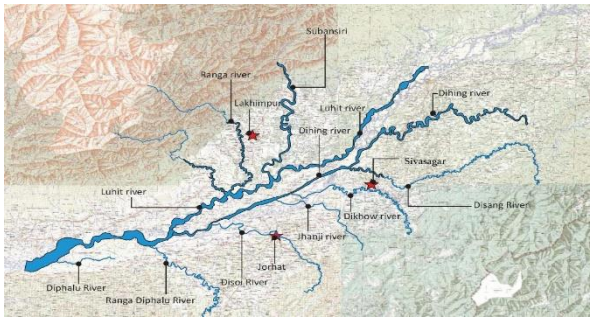


Fig1: Map of Brahmaputra and its Tributaries

The Ganges river dolphin has a sturdy, yet flexible, body with large flippers and a low triangular dorsal fin. It weighs upto 150kg. The calves are chocolate brown at birth and become grayish brown in adulthood with a smooth and hairless skin. Females are larger than males. The maximum size of a female is 2.67 m and of a male 2.12 m. Females attain sexual maturity

at an age of 10-12 years, while the males mature earlier. The gestation period is 9-11 months and a female gives birth to only one calf, once in 2-3 years.

The Ganges dolphin is found in Ganges-Brahmaputra-Meghna and Karnaphuli river system of India, Nepal and Banglades. In the nineteenth century, the dolphins were plentiful in the entire distributional range, though no actual data on population is available (Sinha & Sharma 2003). However, due to various pressures the distributional ranges and abundance of this species has been sharply declined in its entire distributional ranges (Reeves & Leatherwood 1995) and for which the IUCN revised its threatened status from Vulnerable (Klinowska 1991) to Endangered (IUCN 1996). At present there are not more than 2500 individuals of this species in the world.

Dolphins need echolocation to navigate, locate prey, hunt, protect themselves from predators in murky waters or where there is no sunlight and to communicate. In fact, in deep dark waters, their sense of sight is almost nil, but they do not need it because they can detect and chase fast prey through the emission of sounds. Dolphins produce sounds from the nasal air sacs, the blowhole, the larynx, the lungs, and the melon. This latter is an organ located in the upper inner area of the head filled with low-density lipids. First, the dolphin opens the blowhole to make an inhalation and the nasal air sacs swell as the air enters the lungs. Then the dolphin exhales: the air resonates in the nasal sacs and comes out with pressure through the blowhole. Vibrations occur in the larynx, and the nasal air sacs deflate. For echolocation, dolphins emit ultrasounds called “clicks” by pushing air between the phonic lips of the nasal passages. When these lips open and close, the surrounding tissues vibrate and produce sound waves. The passage of air through the respiratory cavities generates the sounds. The Dolphins have an organ in the head, called melon, that allows the transmission of the sound waves. The melon concentrates the pulsations that the dolphin emits and sends them forward. The primary “function” of this organ is to group sounds into beams and produce and amplify the resonance. Once the emission is released forward, the sound waves bounce back in the objects that are in the water. A part of the signal bounces back in the objects and returns as an echo to the dolphin. Their brain receives the sound waves in the form of nerve impulses, and the dolphin can interpret this echo.

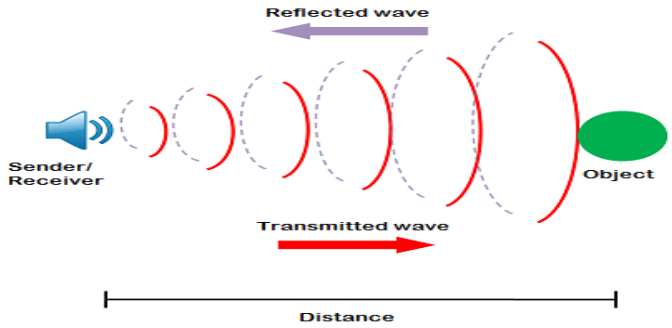


Fig1: Sound Navigation of River Dolphins

The receiver of the returning sound waves is in the lower jaw, and the teeth of dolphins work like antennas to receive the signals. It is a very complex adaptation vital for their survival. The intensity, pitch, and time that it takes the echo to return to the dolphin provide information about the target, such as its size, shape, composition, position, distance, and direction. Based on this, the dolphin builds an image of its environment and the object.

Dolphins use sound to detect the size, shape, and speed of objects hundreds of yards away. Fascinating and complex, the dolphin's natural sonar, called echolocation, is so precise it can determine the difference between a golf ball and a ping-pong ball based solely on density. Although humans have researched these intelligent marine mammals for decades, much of their acoustical world remains a mystery.

One of the keys to dolphin echolocation is water's superb conduction of sound. Sound waves travel 4.5 times faster in water than they do in the air. Using nasal sacs in their heads, dolphins send out rapid clicks that pass through their bulbous forehead, or "melon." The sound is focused, then beamed out in front of the dolphin. The sound wave speeds through the water, bounces off the object under investigation, and is reflected back to the dolphin. Fat-filled cavities in the dolphin's lower jaw receive this information and auditory nerves conduct it to the middle ear and brain, where an acoustic picture is created.

Rivers are at risk from multiple stressors, including changes in water quantity and quality, habitat modification, over-exploitation of resources, climate change, pollution, and invasive species. The current impacts of these stressors on rivers are dramatically increasing. In addition, biodiversity in freshwater ecosystems is in rapid decline, and this reduction in freshwater system is considered even more threatened than are marine ecosystems.

All of the existing river dolphins are endangered, mainly due to human activities and multiple threats, including direct or incidental catch; hydroelectric power plants; construction of dams, barrages, and embankments; strikes by vessels; chemical pollution from the discharge of domestic effluents, from the agriculture, industry, mining, and health sector; noise pollution due to underwater explosions and vessels; and deforestation, which lead to heavy siltation and competing demands of freshwater for irrigation, especially in the Indian subcontinent.

Fig2: Noise Effected Ganges River Dolphins

For conservation of Ganges River Dolphins, we have to take successful strategies. This species has been included in Schedule I of the Indian Wildlife (Protection) Act 1972, and categorised as Endangered on the International Union for the Conservation of Nature's (IUCN) Red List. Successful strategies to facilitate the recovery of depleted populations, reverse trends of population decline and habitat deterioration, and ensure that robust populations with high-quality habitat are secure will need to be multifaceted, adaptable, and tailored to particular local or regional conditions. The many elements outlined below are integral to a comprehensive conservation strategy for the Ganges River dolphin.

Developing and encouraging alternative fishing techniques. Dolphin oil is used as bait to attract two target fish species (*Clupisoma garua* and *Eutropiichthys vacha*), which are then netted or hooked. This use of dolphin oil and their body parts creates an incentive for hunting dolphins and a disincentive for fishermen to release any that may become entangled in their nets. Oil extracted from fish offal available at outdoor markets has been tested and found to be an effective substitute for dolphin oil and encouraging its use may result in a reduction of dolphin kills. Reducing the effects of water development on rivers in Brahmaputra basin. The Ganges River dolphins need to be considered in the assessment of impacts of water development projects. The preferred option from a conservation perspective is to refrain from interfering with the natural flow regime and to avoid constructing barriers to animals and sediment movement. However, socio-political conditions make it impractical to completely halt water developmental activities especially in the Ganga basin, so the immediate goal must be to manage such activities in ways that will minimise the harm to dolphins and other aquatic species.

MIGRATION IN INDIAN OCEAN REGION : TRENDS, PATTERNS AND ESTIMATES.

Dimple Khilwani

Since the end of 1960s and the 1970s the Indian Ocean and its bordering states have been of growing significance in world geopolitics and global geo-strategy. It is a region of great diversity and contrasts in terms of politics,population,economy and environment. Since the end of cold war, the region has been in a period of great instability and regional rearrangement that is still ongoing today.

The estimated number of international migrants has increased dramatically over past 50 years, from estimates around 77 million in 1960 to around 258 million in 2017 [1]. The volume of cross border movements that many countries around the world are facing is increasing and shows no signs of abating. Alongside increasing global mobility, more generally there has been over recent years, and increase in refugees and asylum seekers globally. With changes in global migration occurring at a more rapid pace than perhaps ever before, it is essential to view global irregular maritime migration. In terms of the proportion of migrants that are thought to travel irregularly, broad estimates are available to provide indications of irregular migration globally. The United Nations, for example, has estimated that globally there are approximately 30 to 40 million irregular or undocumented migrants, a number that equates to between 15 and 20 percent of all international migrants [2].

International Migration is a critical concern for implementation of sustainable development. The number of international migrants worldwide has continued to grow rapidly in recent years, reaching 258 million in 2017, up from 220 million in 2010 and 173 million in 2000. Over 60 per cent of all international migrants live in Asia (80 million) or Europe (78 million). In today's increasingly interconnected world, international migration has become a reality that touches nearly all corners of the globe. Modern transportation has made it easier, cheaper and faster for people to move in search of jobs, opportunity, education and quality of life. At the same time conflict, poverty, inequality and a lack of sustainable livelihoods compel people to leave their homes to seek a better future for themselves and their families abroad. When supported by appropriate policies, migration can contribute to inclusive and sustainable economic growth and development in both home and host communities. Countries of destination benefit significantly from migration as migrants often fill critical labour gaps, create jobs as entrepreneurs, and pay taxes and social security contributions. Some migrants are among the most dynamic members of the host society contributing to the development of science and technology and enriching their host communities by providing cultural diversity. Despite the significant benefits of migration, some migrants remain among the most vulnerable members of society.

Factors influencing migration:-

Socio Political : Explores some of the factors contributing to migration and population movement. Numerous domestic and foreign or should we say push or pull factors can encourage migration. This includes ethnic, religious, racial and cultural persecution ;

warfare/threat of conflict plays major role. The politicization of religious and ethnic identities has potential to cause significant levels of conflict within states. Several states within IOR including Burma have recently begin to democratize while failing to simultaneously develop a national identity capable of tying together the various groups within their borders. Once such example in our own Indian Subcontinent is Rohnigya Crisis wherein Rohingya an ethnic group of Rakhine state of Myanmar were neglected by their own government and eventually leading to the situation where 19,500 registered and unregistered Rohingya, including some Bangladeshis, have fled by boat from Bangladesh and North Arakan State, with an estimated 100 people having drowned during the process. Refugees who have fled from the Rakhine state as a result of the violence and unrest, have crossed waters on boats and reached countries like Thailand, Malaysia, and Australia among others. Malaysia, Indonesia and Gambia have agreed to provide refuge to the Rohingya Muslims for the time being. India has refused to take in Rohingya Muslims as they did enter the conflicted area of Jammu and Kashmir, Indian security was concerned that the growing Islamic population in the region would further increase the severity of the religious conflict in the region and therefore refused to provide aid. These people were also called as the boat people. The future level of migration from these countries is wholly dependent upon the longevity and severity of any conflict that could arise from social grievances.

Economic Factors: It relates labor standards of a country, it's unemployment situation and overall health of its economy. According to migration policy institute, migration between developing countries is built upon proximity, identity networks, income differentials and seasonal migrations.

Ecological Factors: Climate Disruptions exacerbates other forces : Climate change arguably is the most serious of all. This will have an impact upon water resources, agriculture, food security, public health and in some instances threaten the very existence of some states. Food and water security to become more salient issues over the coming decades. Increasing water insecurity in parts of IOR, especially, has the potential to influence migration.

Understanding the scale and nature of irregular migration is important, not only in global context but also in a global context, as a means of identifying trends and patterns for a range of policy, economic and geopolitical reasons. There are, however, significant challenges in establishing reliable estimates upon which meaningful analysis and useful comparisons can be made.

Geography plays a fundamental role in migration flows. The physical proximity of source and destination countries as well as the nature of their geographic positioning—land borders, sea/ocean channels—is a significant factor in people movement. The ease (or otherwise) in which people are able to travel irregularly using different modes of transport is an important factor.

VESSEL DESIGN ASPECTS IN THE INLAND WATER TRANSPORT PUSH IN INDIA

A NEW PERSPECTIVE TO SUSTAINABLE GROWTH

Sai Pradeep

In the recent decades, mankind is becoming more and more aware of the importance of oceans in sustaining life on earth. Scientists are in continuous pursuit to understand the oceans from different perspectives such as physical, chemical, biological etc. and also at the same time trying to understand the ill effects of humans on oceans. Among the various anthropogenic disturbances which are being studied, Noise pollution through shipping is one of the major concern after the over fishing and the litter and microplastics.

This issue of Noise Pollution is taken seriously first by European countries and subsequently in a small scale by various other countries, and most importantly by IMO (International Maritime Organization). Various widely signed agreements relating to Underwater noise are MSFD (Marine strategic Framework Directive), HELCOM, OSPAR Convention and ASCOBAN etc. It is required to widely study the regional marine life before setting up regulations. At present the importance is given to oceans and seas but the inland waters are not to be neglected.

India as part of its development strategies, is giving special interest to bring back the supremacy of India as a Maritime Nation. Sagarmala is one of the prestigious ongoing projects of the government which is also aimed at developing and utilizing our vast inland water ways at its true potential. Our inland water transport is likely to rise multiple folds in the coming years. So, I feel it would be the right time to form strategic regulations to save our biodiversity in inland waters and in our EEZ. The Maritime Research Centre (MRC) through its UDA summer school program is trying to make Young India aware of our maritime potential and its opportunities.

As India is on the verge of a boom in its maritime & inland water transport, the vessel traffic, which are the major sources of anthropogenic noise are to be optimally designed to reduce their radiated noise. So, understanding various design aspects of the ship which affect the noise emitted from them are worth studying, for minimizing the radiated noise.

The major sources of noise from ships have been identified and efforts are being made to improve the design. The major sources of noise from ships are the propellers, onboard machinery and hull form itself. Various methods to predict the noise and possible areas of improvements in design are published globally in various research papers, textbooks. Here I am trying to summarize my understanding of various studies done globally.

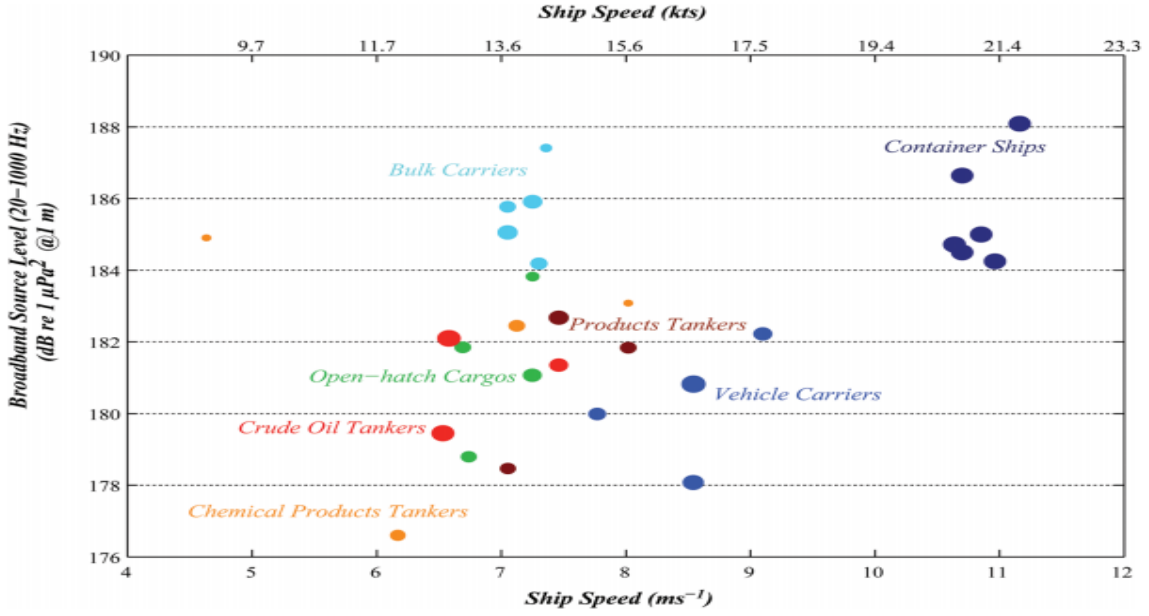
Propellers are the major source of noise generated by a ship. Globally various studies are being carried out in the design of propellers and lot of advancements have been made. There are many choices of propellers available for ships to choose from. The propeller should give more thrust and speed while radiating low noise. The improvement of the propeller design is mostly happening for the deep-sea environment. But the propeller performance in inland waters are much more complex to study. As per the literature and statistics, Ducted propellers are best for river vessels followed by normal screw propellers and Azimuthal propulsion when noise is

considered in cavitating environment. But at the same time wear and erosion of the ducted propellers is more when compared with other types. Cost also plays an important role in choosing the propeller.

Hull form of the ship plays an important role in reducing noise indirectly. Propeller performance is very much dependent on the wake field created by the hull. The primary principle for designing the hull is the cargo or which is intended to carry, and to reduce the resistance of the ship. The hull form and the propeller design are to go hand in hand for the best design. So, it is not possible to decide best propeller for ships, rather it is to be studied case by case basis. Structural optimization of the hull form is also required to reduce its excitation responses and studies to be done on the transmission of structure borne noises through the hull. The smoothness of the hull surface makes a huge difference in containing the noise generated.

On-board Machinery is the major noise creators from inside the hull. There are many powering configurations available to choose from, Diesel electric propulsion is less noisy when compared to diesel propulsion, then again, we have to choose propulsion system useful for the particular capacity and type of the ship. The same configuration is never feasible for all ships. The following steps may be taken to reduce the effect of vibration and noise transmitted by the onboard machinery - proper location of the equipment, suitable mountings for foundation, dynamic balancing of reciprocating machines.

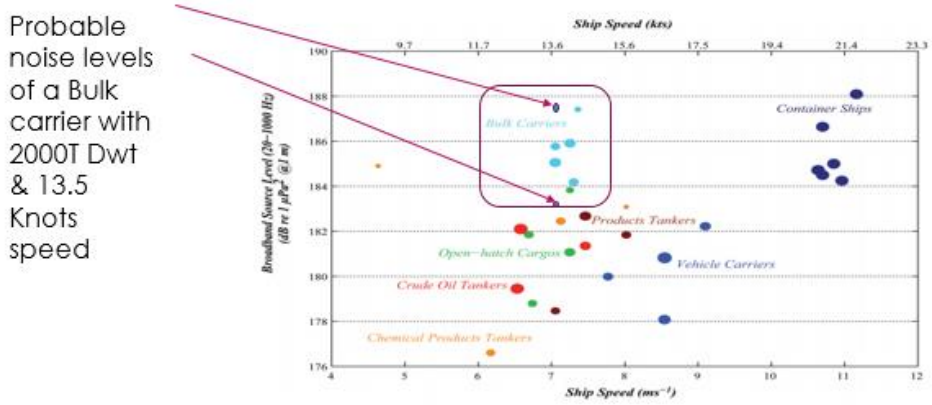
The below graph has been taken from research paper "Under water Radiated Noise from Commercial Ships" shows the broadband noise levels of different commercial ships as per their Gross Tonnage and speed.



In the above bubble color describes ship type and the bubble size describes the relative size of the ship.

India by its inland water ways is most likely to transport dry bulk cargo like cement and coal, liquid cargo like petroleum products in major quantities as per Sagarmala reports. I have taken a 2000 T dead weight bulk carrier as these ships have a draft of around 2.5 to 3m which are in

same range of navigational drafts in our inland waters and try to plot the same in the above. The probable broadband frequencies in the graph is as shown below



It is important to state here that the frequency of sound waves from ships and marine mammals (for which scientists are able to detect) are in the ranges of 10hz-1000hz and 10hz-2000hz respectively. So, if the amplitudes of sound waves are high in ships than the mammals which is most likely, Marine mammals would not be able to communicate because of masking. Also, the high amplitudes of sound found to cause problems for mammals in their foraging and sometimes in their reproduction. The same may be applicable for fresh water mammals and fishes.

So, strategies to be framed to avoid the possible damage that may be created by the inland water vessels to fresh water fish and mammals. Study is required to know the communication frequencies of fresh water mammals and fishes (for those which use sound as a medium of communication). Sensitive areas may be identified to reduce ship traffic in those regions. Vessel design is to be improved to reduce their radiated noise.

Underwater Domain Awareness (UDA) Summer School

Six Weeks Project Based Internship Programme: 4 June to 14 July, 2018

Contact E-Mail
c.udasummerschool@gmail.com

Date: 17 Jul 2018

To,

Amarjyoti Kumar
B.Tech Third Year, Electronics and Communication
Assam Don Bosco University, Guwahati

Subject: Letter of Appreciation

Dear *Amarjyoti Kumar*,

The UDA Summer School-2018, concluded on a very positive note. I would like to place on record my appreciation for your whole hearted participation in all the activities both at Pune and Goa. The diligent efforts in shaping your project titled

" Impact of Heightened Traffic on the Acoustic Habitat of the Brahmaputra River "

was extremely encouraging and we would like to support you in future to take forward the good work. We sincerely hope that the learning you have got here will benefit you in future to pursue career goals in a much more effective manner.

The formal certificates signed by Vice Chancellor of Pune and Goa University, President Indian Maritime Foundation, Pune and Shri Jayantrao Sahasrabuddhe Organizing Secretary of Vijnana Bharati is being issued in a short while.

Keep up the good work and do consider contributing to the UDA cause for a comprehensive national framework, given the huge maritime potential that we possess in the Indian Ocean Region. The organizers are working towards generating massive opportunities in the future and your participation will be very critical in taking the strategic national vision forward. I am sure there will be meaningful career opportunities for you as well.

Option of Project Internships and Fellowships at the Maritime Research Centre (MRC) are always open for you.

With Warm Wishes,

Dr (Cdr) Arnab Das
Convener, UDA Summer School
Director, Maritime Research Center

Maritime Research Center, Pune

Savitribai Phule Pune University

Vijnana Bharati, Pune

Goa University

NirDhwani Technology Pvt. Ltd.

NIO, Goa

NCAOR, Goa

Vijnana Parishad, Goa

L&T Defence

This is to certify that

Mr. Jaswantsing Rajput

has successfully completed the six weeks internship as part of the

UDA Summer School 2018

and worked on the project titled

Modeling Cumulative Acoustic Energy from Shipping in the Indian Ocean Region.

Cmde Rajan Vir (Retd) *President Indian Maritime Foundation Pune*	***Prof Nitin Karmalkar*** *Vice-Chancellor Savitribai Phule Pune University*	***Prof Varun Sahni*** *Vice-Chancellor Goa University*	***Shri Jayant Sahasrabuddhe*** *National Organising Secretary Vijnana Bharati*

Feedback from Participants

UDA Summer School : An unforgettable Experience

As a young adult, I feel fortunate enough to be able to share my UDA experience today. I am thankful that my parents instilled in me the value of exploring and its role in acquiring a good experience. I know that had it not been for my love of experience and pursuit of knowledge, I wouldn't be the person I will be in near future, for I have decided mu future path.

This summer the perfect lifetime opportunity came up for me: The 'UDA Opportunity'. This summer school or should I say the UDA family provided basic insights on maritime domain awareness. The participants ranged in age from their 20's to 50's, from varying domains and geographical locations. Being around people who shared different backgrounds and world views from myself, allowed me to broaden the scope of ideas I was being exposed to and explore different insights and views on life forms that I ever had before. I took this opportunity with great zeal.

The UDA summer school offered us an unique chance to learn and discuss about basics, current issues and future trends in the maritime area with high profile lectures by keynote speakers on data science, coastal engineering, structured innovation and global geopolitical chokepoints. One thing that I believe to be highlighted is that every guest speaker had enough academic background in their respective fields and are professionally way active, this in turn integrated great deal of practical cases and examples into the sessions that were strategically planned. The knowledge that we gained gave us the decisive advantage for our future carrier options and application process. We got the chance to build a personal and professional network of young talents and leading experts in this domain.

The course featured practical insights through national research institutional visits to NIO, NCAOR, NIH and NCMR with a focus on UDA with its deep roots in the underwater domain and marine environment discussed recent development by our nation in the area by taking regional, national and international specifiers into the account. We were given the opportunity to visit experimental laboratories of these institutes equipped with highly sophisticated modern machineries which gave us a chance of learning theoretical tools necessary to understand the complex design for science goals. Our interaction with the staff and the young researchers at the institute provided each one of us a flavour of research pursuits at the institutes. We were also taken to centres like IUCCA, MPT and Goa Shipyard.

From the first week of the summer school, we all were involved in our respective projects, mine was Migration in IOR: Trends, Estimates and triggers.

If there is one overarching principle that UDA made me realise however, it is that I'm extremely metamorphically hungry, hungry to grab knowledge.

All in all I'm grateful to have had the chance to participate in the course. My expectations concerning what I would learn in these 6 weeks were surpassed. Dr Arnab Das Sir did a great job by giving us this platform and looking after us. I plan to further extend my knowledge and skill set which I learned in the course in the hope of participating in future projects in near future. This training gave me the opportunity of living two passions at the same time: Journalism and getting to know about a sustainable career. Thanks to Arnab Sir. I sensed that this training raised awareness on the all potential discoveries that are waiting for us in the part of the world. It also showed that we have a lot to learn. In the end I'd like to say that the underwater domain is of a great importance and there's a lot to be done in our own region. Thanks for the success of this course goes to all supporters and collaborators.

Dimple Khilwani

I would like to express my sincere gratitude to everyone involved in organising this UDA Summer School program. It gave us a completely different perspective towards marine eco-concern and its impact.

I, specifically, would like to thank our convener Dr.(Cdr) Arnab Das Sir for helping and guiding us in each step of the event. Sir was always ready with a solution to all our problem. Thank you sir, without you we would not have been able to realize how different disciplines can contribute to the field of maritime research.

I also wish to thank all the renowned speakers from different field who enlightened us with their real life experience and knowledge. My sincere gratitude to all the institutions involved for organising such a beautiful event. I would like to thank all the coordinator for their continuous support throughout the event.

Lastly, I wish to thank each and every one who were involved directly or indirectly in organising this wonderful event.

Thank you so much to all the participants from different regions of India who became a family towards the end of the event.

My best wishes for the success of this event further.

With thanks and regards,

Jayashree Deka,

The term UDA was of no significance to a commoner like me. Someone like me never understood what lied within the oceans or how beautiful are the creatures within it. I never understood what struggles the Indian Navy had to undergo or what battles they fought. I thought war was fought just on land and for the land. But a war brewed in the water as well was something I had no idea of.

A journey in UDA has thought me a lot of something, be it data science or the wildlife conservation or how the crabs facilitated their journey or how to present your ideas in front of a large group of big and influential people, UDA had given it all.

Speaking and presenting in front of people had always been my forte. But when I stood in front of so many people, I started having cold feet. I was scared and tensed; I didn't know how to start. But I did and I had no idea what was I saying because it wasn't something that I thought I would say and I was quite disappointed in myself that day. In other words, I faced my first failure in UDA. But as the saying goes failure is the pillar of success and so with another attempt I was back on track and gave my best in the last presentation, maybe I just needed that extra push, a push that said that there are people better than me.

UDA was not just about integrating information in you, but it also gave a feel of competition in the real world. Meeting so many people having different backgrounds was fruitful as well as exciting. There were people from all walks of life with varied ideas, motive and cultures. But one thing everyone had in common was the need to do something good for the nation and its people. Whether it was a tech guy or a PhD holder or a marine archaeologist, everyone was unique and similar in their own way.

All work and no play make Jack a dull boy and I think UDA believed in it as well. Apart from working on our projects and meeting all the influential people we could in that nick of a time, we had fun as well. A trip was organized for us with a knowledgeable tour guide to see all the places and know the history behind it. It was an exciting adventure which could never be forgotten. A trek had also been organized for us as a non academic activity by Praful Talera Sir, who showed us you need to be fit not just mentally but physically as well because we need both our

At the end of this 6 weeks summer internship, I can proudly say that I'm more knowledgeable about the marine environment, be it in terms of economic or cultural value. I'm even taking an idea of a project which I'm currently working on using the tools I learnt in UDA. On one hand where my classmates are busy surfing through already researched projects, I've already decided what I want to do, Thanks to UDA. At last I just want to say Thank You UDA for this wonderful opportunity.

Nisha Kalita

The Underwater Domain Awareness was a knowledge gaining experience. The course was wonderful and enlightening which provided an opportunity to learn from experiences of various field experts. Interactive sessions with dignitaries helped in gaining knowledge from various domains. UDA provided unique opportunity and exposure to different organizations and the work culture. UDA has come up with a new concept which is designed and focused in a way to enable young generation with wide spread knowledge from various fields and with a foresight of making India as a maritime super power. It was not only an academic program but a source of an overall development. I am happy that i had an opportunity and I look forward to implementing this learning and spreading the same.

Dy Comdt C B Shaik
Indian Coast Guard

When I first heard about the UDA summer school I was quite cynical about its aforementioned goals. But as time passed in this summer I came to understand that I was grossly incorrect, this summer school is a stepping stone to that dream of restoring India's glory as a maritime superpower. The approach that this school has utilized is quite unique in today's standards. The free mixing of different domains has been a calculated risk that the UDA has taken. This mixing has enabled us to expand our approach and broaden our thoughts. Another thing worth mentioning is the ways all participants were made to live and learn together like a family, something that we would cherish for long. The professionalism that we experienced here was commendable apart from the exquisite hospitality that we received.

As alumni of this school we hope that we would see a network being created from here for the symbiotic benefit of each individual associated with this school. The last thing that we would say is that the experience and the knowledge gained here is satisfying as well as richening. Thank you UDA summer school and Dr. Arnab Das for this experience.

Ankit Biswas

All the memories that I carried in the core of my heart during the 45 days in UDA summer school will be a matter of happiness forever and it makes me nostalgic when I was leaving the school. The UDA summer school gave me a chance to know what is actually happening underwater and most importantly how a group of people from various disciplines and also geographically from different places can work together under the same roof as a family and the information I gather visiting the various Institutions like NCMR, NIO, NIH, NCAOR etc. encouraged me to become a part of it. Yoga, eco walk and the tracking adds more value to the entire programme. I also enjoyed the Pune darshan. The entire internship summed up with knowledge of various disciplines and it helps in igniting the quest for more knowledge, explore and understand every little thing around us staring from what is micro-plastic to various other things. I must give a heart full thanks to sir Arnab for his effort and the exposures that he tried to give us. I will conclude by writing that something ends to begin or to give rise some beautiful new paths leads to a new starting. Long live UDA summer school.

Rohan Boruah

It has been very nice experience of **Underwater Domain Awareness** (UDA) summer school June 04, 2018 – July 13, 2018. "I REALLY enjoyed this workshop for many reasons…not least for interacting with professionals from various disciplines who all have the same interest in UDA. I thankful to Dr. (Cdr.) Arnab Das sir for arranging such a nice multidisciplinary summer school.

The first week was knowledgeable. We had a informative talks of Dr. (Cdr.) Arnab Das sir and Mr. Umesh sir. We had first two days talk on, what is marine life? Which are the different areas of research in underwater domain by Dr. Arnab sir and three days workshop on 'Data science' & introduction to programming in python, MATLAB, H_2O by Mr. Umesh Gupta sir. We all feel that we learnt a lot about data science viz, and it was really fun too. Not something I find myself saying about workshops very often! It was relevant for all of us. On weekend we had a trip to *'Pune-Darshan'.*

In second week, we had opportunity to attend special talks of Dr. T. M. Parchure on very important area of underwater domain that is costal engineering for two days. He enlighten us on various aspects of costal engineering such as numerical and physical modelling techniques for port planning and development. We had a guest lecture on report writing and communication skill by Ms. Scharada Dubey. She has shown us a different view of writing skills. We had a Bio-diversity walk followed by a lecture on the same by Dr. Sachin Punekar.

The all areas of ocean are covered in six weeks. The most exciting part of the summer school is visit to various national research and defence institutes like National institute of oceanography (NIO) Goa, National centre for microbial research Pune, Indian Institute of hydrography (NIH), Indian Navi, Indian Coast guard, NCAOR. Along with this we had visited to Indian Shipyard, Marine Industry, Marmagoa Port We had interacted with subject experts at these places.

Overall the summer school was very informative. As a Indian we should have a awareness about the Indian ocean region and how to protect it from plastic and micro plastic because this plastic is disturbing the marine life.

Lastly, I want to thank Dr. Arnab Das sir, team of Vidnyan Bharti, Pune University, Goa University, MRC and NIO for giving this wonderful opportunity to see ocean and underwater life.

Thank you…..

Digambar Puri

The underwater domain awareness was a thoroughly enriching experience. I have three different yet connected backgrounds of History, Archaeology and Museology. One might wonder what I learnt from this, but to state the facts it is immense. Ranging from intensive sessions by experts from varied backgrounds was enlightening, to understand the existence of a completely different world. The unique opportunity to interact with dignitaries and domain experts was an amazing learning experience, rare to obtain. The exposure to different organizations, establishing contacts and various field visits enabled the building of a team spirit and to work as a cohesive group could not be fathomed in a summer school. It has given me a new dimension to think, perceive and contribute to our nation with the help of studying the oceans. It was not only an academic program but a source of an overall development. I'm glad I got this one of a kind opportunity And I look forward to implementing this learning and spreading the same.

Tiya Chatterji

Summer School was very Informative for us. Actually underwater domain was unknown for me but, this summer school helped me a lot. All sessions were properly planned and Expert speakers were really very informative. Apart from this Beach walk at Goa,Pune darshan, Bio diversity walk,Watching of " PARAMANU" movie and Yoga day celebration has made it a lifetime memorable event. Arnab sir has taken care of each participant, also personally guided us on our project topic that really helped me a lot in my Ph.D seminar presentation. Accommodation at Pune University and Goa University was very good. Food quality was also very good.
Sir's personal attention everything is really appreciable.

Mr.Prafullaji Talera made our Poona phase a memorable one and his interaction with us was very friendly. Mr. Jayantji's two meetings and group discussion really motivated us to work for the nation. I must say Thanks to them.

Hope that this event shall be continued in future, I shall definitely take part in it. Last but not least Mr.Shridhar Prabhuraman also helped me a lot in my project topic. I am also thankful to him.

I am thankful to University of Pune (SPPU), Dept.of Technology, Goa University, Nirdhwani Technologies, L&T Defence, NIO Goa, Vidnyan bharati Pune, Vidnyan parishad Goa & Indian Maritime Foundation.

Thanks a lot,
Jaswantsing Rajput

The six weeks in UDA Summer School was a great experience for me. I got the opportunity to know about many new things related to the marine field which i don't even thing there exist such a vast underwater environment. Also I would like to thank each and everyone associated with UDA Summer School 2018, as everyone played their role satisfactorily.

Amarjyoti Kumar

Underwater domain is new concept for me and we learned lot of think like phyton, coustal engg, marine conservation, impact on marine life etc. and goa's experience is also very good experience. We also visited NIH, NIO, NCAOR and got an opportunity to interact with various expert over all it was a very great experience and I wish to thank Dr. (cdr)Arnab sir,speakers, supporters,and organizser for organising such event which help us in understanding the need for awareness in this field. And I get best direction towards my career from this intership thank you.

Aditi Pawane

Six week UDA program has been a long journey and it has changed the very way in which I see the ocean now. It has been a phenomenal experience. Meeting with all big dignitaries was a wonderful opportunity and chance to interact with stalvarts of the various fields made it all worth the while.The whole event management was seamless. Arnab sir's continuous support and guidance has made the whole program very fulfilling and satisfying. I look forward to contribute in whatever way possible to future endeavors of MRC.

Thanking you,
Karan K. Bhat

First of all, I am very happy to say that, now i am one of the part of UDA summer school. I am thankful to each and every person, those who are directly or indirectly related to UDA and also I am thankful to Dr, Arnab sir, for giving me this opportunity. For me It was a great experience. Because of UDA , now i can realize the importance of under water. Specially the overall impact of ocean on the entire world. For me, this journey was one of the best experience in my life. Especially UDA teach me the new learning process from anything and anywhere. For giving me this wonderful experience, i am always thankful to UDA summer school.

Thank You so much,
Ilakshi Deka

Respected all,

I wish to express my sincere gratitude to each and every one involved in organising such a masterpiece event. It brought us face to face to the realities that exist in life and the extent to which we as individuals can contribute to develop the nation in a more sustainable manner.

I specifically wish to thank our convener Dr.(cdr) Arnab Das sir for being with us in each step of the event and making sure that always the best reached us. Also for making sure that people from every discipline found it convenient to cope up with the multiple disciples of the events. Sir was someone who understood our difficulties and gave us the best possible solution. Thank you so much sir, without your presence the event would have not been so memorable.

Also I wish to express my gratitude for bringing in such renowned speakers who enlightened us with their ocean of knowledge and gave us an opportunity to think beyond our disciple. Thank you for sparing your precious time in making us aware of crucial need to understand and protected this domain of life. I also wish to thank all the institution involved for giving us such a great opportunity to be a part of it and for helping us to learn beyond.

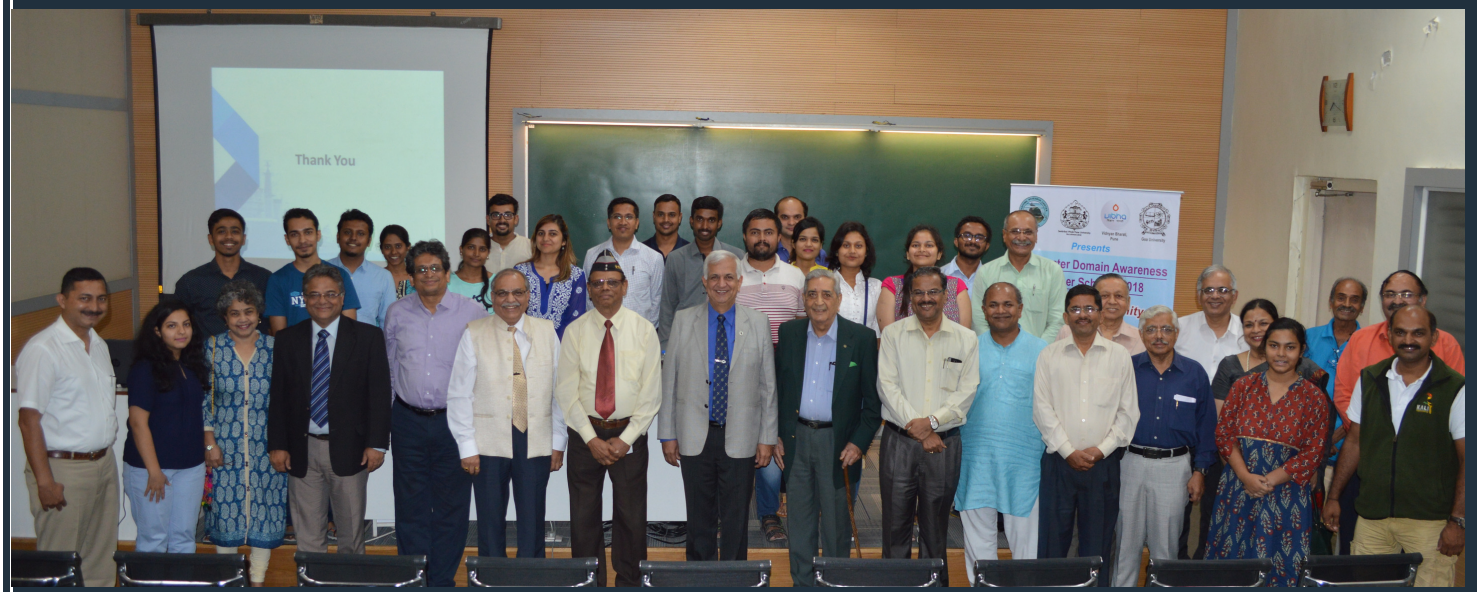
Also wish to express my gratitude to the great coordinators involved who worked tirelessly in bringing the ends together. Without their unconditional support and guidance throughout, it would have been difficult for us to complete this event so smoothly. Thank you so much.
My sincere gratitude to all those who support this event in one way or the other, without their support this event would not have commenced so beautifully.

Finally I wish to thank each and every one responsible for making this wonderful event come true and for having us as a part of it. It was a great pleasure to be a part of the UDA Summer School, which bestowed upon us with such ocean of knowledge whose learning otherwise would not have been possible. Thank you so much everyone.

Towards the end we look forward to take this awareness one step further and motivate more individuals to be a part of this wonderful domain.

Thank you so much for organizing such a wonderful event. Our best wishes for the great success of this event further.

Thank you so much.
With warm regards
Divya Nagarajan



Find out more by

visiting : www.mrcpune.indianmaritimefoundation.org

e-mailing : c.udasummerschool@gmail.com

One Journey Ends.....

Another Begins !

Find out more by

visiting : www.mrcpune.indianmaritimefoundation.org

e-mailing : c.udasummerschool@gmail.com